UNIV. OF
TORONTO
LIBRARY

Digitized by the Internet Archive
in 2008 with funding from
Microsoft Corporation

http://www.archive.org/details/engineeringcontr29chicuoft

Engineering-Contracting

A Weekly Journal for Civil Engineers and Contractors
With which are Incorporated

ENGINEERING WORLD AND CONTRACT NEWS

VOLUME XXIX

January-June, 1908

104835
14/9/10

THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn St., Chicago, Ill.

INDEX

VOL. XXIX, JANUARY-JUNE, 1908

A

- Abutments, Concrete, Method of Designing 42
- Advertisements.
  - Captions for, Importance of Good 303
  - Cuts for, Kinds to Use 327
  - Display, Use and Limitations of 375
  - Educational, Value of 363
  - Keying, Methods of 291
  - Slogan, Effectiveness of 315
  - Writing, Suggestions on 349
- Advertising, Educational, Methods of 185
- Air Compressors, Steam Consumption, Tables for Calculating 215
- Alkalies, Mortars, Destruction by 376
- American Society of Engineering Contractors.
  - Letters Commending, 170, 179, 199, 217, 224, 237 301
  - List of Applicants for Membership 131
- "Approximate Estimate," Meaning of, in Specifications 155
- Aqueducts, Cost of Concrete, Comparison of 93
- Arches.
  - Long Span Concrete, Possibilities of 52
  - Luten, Description of 3
  - Ribbed Concrete 31
- Artesian Wells, Cost of 218
- Ashes, Removing, Cost of 243
- Asphalt Repair Plants.
  - Brooklyn, N Y 321
  - New Orleans, La 87
- Asphalts, Apparatus for Extracting with Solvents 75
- Association of Concrete Workers, English .315
- Association of Licensed Cement Manufacturers 65

B

- Bankers Engineers, Duties of 231
- Belt Conveyors, Power Consumed by 165
- Blast Holes, Drilling with Drill Rod 310
- Blasting Caps, Testing, Method of 62
- Blasting Ice, Method of 148
- Blue Printing Machine, Continuous 61
- Blue Prints.
  - Continuous, Machine for Making 61
  - Copying, Methods of 300
- "Board Walk," Concrete, Atlantic City, N. J. 69
- Bond, Steel with Concrete, Tests of 5
- Breakwaters, Reinforced Concrete Caisson 246, 352
- Bridge Pier, Pile and Grillage Construction for 51
- Bridges.
  - Arch Concrete.
    - Cost of 3, 31, 378
    - Hudson Memorial, New York 53, 54
    - Method of Construction 3, 31, 378
  - Arch, Steel, Method of Erecting 275
  - Girder, Concrete, Cost of 78, 136
  - Highway, Advantages of Concrete for .. 187
  - Manhattan Suspension, New York, Anchorage Construction 163
  - Painting, Cost of 180
  - Quebec, Failure of.
    - Lesson Taught by 185
    - Report of Royal Commission on 169
  - Truss, Erection by Launching 345
- Briquetting Coal, Cost of 117
- Bucket Elevator, Power Consumed by 165
- Buckets.
  - Clam Shell, Large 381
  - Concrete for Narrow Forms 368
  - Orange-Peel for Handling Rock 70
  - Wood for Contractors 85
- Building Materials, Weights of Various .. 200
- Buildings.
  - Brick.
    - Cost of 229
    - Moving, Method of 200
  - Reinforced Concrete.
    - Construction Methods 80
    - Cost of 247
    - Garage with 75-ft. Girders 317
    - Separately Molded Members 165

C

- Cable, Laying Submerged, Method of 200
- Cableways.
  - Computation of 37
  - Types of 35
- Caissons, Reinforced Concrete for Breakwater 246, 352
- Canals,
  - Curve of Quantities for 369
  - Georgian Bay, Progress of Survey for .. 193
  - Irrigation.
    - Concrete Lining, Cost of 366
    - Klamath Project, Cost of 173
  - Panama.
    - Dredging, Cost of 32
    - Dredging Equipment on 354
    - Steam Shovels, Number Worked, 1906. 29
    - Steam Shovel Work.
      - Cost of 32
      - Records, December, 1907 71
- Card Index Order Systems 348
- Cars.
  - Contractors' Dump, Koppel Steel 63
  - Railway, Cost of Repairs to 252
- Carts, Hauling in, Cost of 57
- Cast Iron Work, Cost of, U. S. Printing Office 171
- Catalogs.
  - Indexing, Methods of 359
  - Sizes of 350
  - Writing, Suggestions on 257
- Catch Basin, Tile for Drainage Work 51
- Cellar Excavation, Cost of 222
- Cement.
  - Storage House for 323
  - Volcanic Ash for 2
- Centers, Arch Bridge 31
- Chimneys, Reinforced Concrete, Safe Design and Construction 304
- Coal, Briquetting, Cost of 117
- Cofferdams.
  - Construction, Methods of for Small 212
  - Cost of 279, 357
  - Leaks, Method of Stopping 51
- Columns.
  - Concrete.
    - Computation of 121
    - Design of 121
    - Limitations of 364
  - Economics of, Comparison of Reinforced Concrete, Cast Iron and Steel 367
  - Hooped Concrete.
    - Structural Value of 327

Tests of 327
Hooped Reinforcement for.................189
Molding Separately, Cost of............165
Computing, Suggestions for................ 16
Concrete.
Abutments, Design of....................... 42
Bond with Steel, Tests of.................. 5
Breaking Up, Methods of...................150
Bridges (see Bridges)........................ 3
Buildings (see Buildings).
Caissons for Breakwater............246, 352
Chimneys, Design and Construction....304
Columns (see Columns).
Compression, Behavior in..................121
Continuity of Reinforcement, Necessity of 134
Coping Walls for Dikes...................... 68
Culvert Construction 16, 353
Defects and Limitations of Reinforced..208
Forms (see Forms).
Foundation Pillars for 14-Story Building 293
Impermeable, Investigations of....119, 120
Mixing, Cost of in Lock....................280
Mixing Plant, Manhattan Bridge Anchorage 163
Pavement Base, Cost of..........195, 378
Pile Underpinning for Engine Foundation 97
Plastering, Method of.......................175
Poles (see Poles).
Proportioning and Mixing..................108
Reinforcement, Comparative Advantages of Loose Bar and Unit Frame Methods 186
Reservoir, Pomona, Cal.....................220
Retaining Walls 16
Roof Slabs for Vault........................ 15
Rubble, Cost of...............................368
Separately Molded Members for Building Construction 165
Surfacing, Spade for........................ 46
Walk, Atlantic City, N. J.................. 69
Concrete Blocks.
Laying, Cost of............................... 2
Manufacture, Methods of in Cuba......365
Silo, Construction of........................ 2
Tests Recommended for....................137
Concrete Bucket for Narrow Forms......368
Concrete Mixers.
Combination Push Cart and Mixer......262
Misstatements Regarding 119
Concrete Mixing, Cost of by Hand and Machine 221
Construction Work, Obstacles to in Arid Regions 60
Contracting, Starting in, Methods of.255, 303
Contractors, Responsibility of for Delays.328
Cost Data, Study of at University of Colorado 16
Costs.
Aqueducts, Concrete, Comparison of.... 93
Artesian Well 218
Asphalt Repair Plants..................87, 321
Blasting Stumps 294, 336
Bridges.
Arch Concrete 3, 31, 378
Gerder, Concrete 78, 136
Briquetting Coal 117
Buildings.
Brick Factory 229
Reinforced Concrete 247
Car Repairs, Railway 252
Cost Iron Work, U. S. Printing Office...171
Cellar Excavation With Steam Shovels.222
Cleaning Steel Work by Sand Blast....230
Cofferdams 279, 357
Concrete Blocks, Laying of............... 2
Concrete Slabs for Vault.................. 15
Contract Labor for Sewers................ 75
Cribwork for Lock............................283
Culverts, Concrete..........16, 97, 221, 353
Curb and Gutter, Concrete................358
Cut Stone, U. S. Printing Office........117
Dam, Ashokan......77, 95, 99, 111, 127, 371
Rubble Concrete 368
Diamond Drilling 248, 263
Digging Holes 8, 91, 139, 223
Ditches, Table for Estimating...........,62
Dragging Earth Roads 290
Drainage Ditching 62
Dredging, Panama Canal 32
Earth Excavation, 6, 8, 32, 47, 50, 57, 59, 62, 69, 85, 94, 102, 126, 139, 169, 173, 223 279
Estimating for Timber and Pile Trestles 104
Excavating Irrigation Canal 173
Forms for Lock 280
Gas Producer Operation 323
Grader Work on Belle Fourche Dam....169
Great Northern Ry. 271
Grinding in Tube Mills..................... 47
Hauling in Carts 57
Laying Water Main Under Water......238
Lining for Irrigation Canal, Concrete..366
Lock Construction, Upper White River, Arkansas 278
Lock Gates 282
Maintenance of Horses in New York City 309
Maintenance of Road Rollers............358
Manholes, Concrete 352
Mining Gold Gravel 225
Mixing Concrete 221, 280
Molding Concrete Columns 165
Molding Concrete Girders 166
Molding Concrete Roof Slabs............166
Mortar for 1,000 Brick.....................221
Northern Pacific Ry. 225
Oiled Roads 60, 181, 265, 314, 337
Painting Railway Bridges 180
Painting Steel Work by Compressed Air 230
Pavement Base, Concrete..........193, 378
Pavements.
Asphalt 86, 87, 194, 195
Representative Cities in 1907.........195
Stone Block 243
Wood Block 137, 300
Paving Materials 149
Pile Treatment With Teredo Proof Paint 206
Pipe Molding, Concrete 171
Pipe Sewer in Quicksand..................341
Placing Reinforcing Steel 300
Poles, Concrete 129, 151
Railways, Great Northern, Estimated..271
Northern Pacific 225
Removing Ashes 243
Reservoir Construction, Concrete.......220
Retaining Wall Construction, Concrete.. 16
Roads.
Grading in Winter 126
Macadam 357
Sand-Clay 241
Yukon Territory 62
Rubble Concrete Dam 368
Scraper Work 102, 138
Sewers, Table for Estimating............200
Shaft Sinking, Rand Colleries...........168
Rock 138
Shoveling and Casting Earth Behind Wall 58
Spreading Earth in Roiled Embankments 249
Steam Scraper Work.......................128
Steam Shovel Work, Belle Fourche Dam 169
Cellar Excavation 222
Panama Canal 32
Steel Sheet Piling for Cofferdam.......357
Street Cleaning 75, 243
Street Sweeping, New York City........267
Surveys, Land 241
Railway 117
Telephone Line Construction............326
Test Borings with Hand Machine..71, 148
Tie Growing 241
Track Construction, Street Railway....152
Transmission Line 14
Trenching, Buckeye Traction Ditcher...103
Electrical Conduits 154
Sewers with Trench Machine......... 69
Trimming and Dressing Frozen Ground. 70
Tunnel Lining, Concrete.........6, 290, 342
Wall Form Construction 46
Wheel Scraper Excavation 59, 102
Wood Lock Gates 282
Creosote Oil, Tests of for Paving Blocks..241
Cribwork Cost of for Lock................283
Cross Wires, Replacing, Method of.......128
Culvert Pipe, Tests of Cast Iron and Reinforced Concrete 232, 244, 257
Culverts.
Concrete, Advantages for Highways...187
Cost of 16, 97, 221, 353
Curbs, Concrete, Cost of..................358
Cut Stone, Cost of, U. S. Printing Office..117

D

Dams, Ashokan, Estimated Cost of, 77, 95, 99, 111, 127..............................371
Belle Fourche, Construction Records...169
Concrete, Cutting Hole Through.......358
Construction, Suggestions for...........215
Gatun, Experiments to Determine Characteristics of Materials for........295
Rubble Concrete, Cost of................368
Steel Bridge, New York Barge Canal..277
Zuni, Completion of 218
Dana, Richard T. 147
Derrick, Hand Power 52
Diamond Drilling.
Cost of, British Columbia...............263
Mexico 248
Dikes, Concrete Coping Walls for, Holland 68
Ditches, Cleaning Scraper for.............290
Construction in Alaska.................. 39
Cost of, Table for Estimating.......... 62
Ditching Machine, Combination Ditching and Tile Laying 320
Traction for Ditches with Sloping Banks 295
Drainage, Agricultural, Development of in Illinois and Iowa 297
Drain Tiles, Cement, Tests of............174
Large Size, Advantages of..............250
Dredges, Electric Operation, India........ 75
Government Operation, Discussion of, 185, 191......................................311
Panama Canal 354
Dredging, Cost of, Panama Canal........ 32
Drill Bits, Shapes for Different Materials.379
Drilling, Drill Road for Blast Holes......310
Hole Through Wall, Method of.........216
Rates of, Plug, for Breaking Stone..... 58
Tunnel Work, Arrangement of Holes... 10
Water Jet for Increasing Speed........ 84
Drills, Electric Air, Merits of.............319
Extricator for Removing..................168
Hammer, Tests of...........................223
Simplex Chuck for 168
Water Power for Shaft Sinking........235
Duckham, A. E. 228
Dust, Laying with Calcium Chloride.....290
Dynamite, Thawing Plant for............. 15

E

Earth, Shrinkage in Reservoir Dam......19[illegible]
Trimming Frozen, Cost of............. 70
Earth Excavation.
Cost of Casting Behind Wall............ 58
Digging Holes 8, 139, 223
Drag Scraper Work......................138
Drainage Ditching 62
Effect of Cold Weather on............ 85
Grader Work 169
Grading Wagon Road 126
Irrigation Canal 173
Loading Into Carts...................... 57
Loading Into Wagons..............47, 85
Panama Canal 32
Scraper Work in Freezing Weather..102
Sewer Tunnel 6
Steam Shovel Work..............169, 222
Trenching for Sewers with Trench Machine 69
Wheelbarrows and Derricks 279
Wheel Scraper Work 59, 138
Device for Breaking Up Hard Clay....105
Steam Scraper Work, Klondike.........128
Earth Slides, Checking, Method of........372
Prevention of in Gumbo Soil........... 62
Eight-Hour Laws, States Having, List of.157
Electric Railways, Depreciation, Allowances for 180
Embankments, Rolling Reservoir, Method of 157
Spreading Earth in, Cost of............249
Engineering Commissions, Business Men for 107
Composition of 173, 376
Engineering-Contracting, Plans for 1908.. 1
Reading Matter in, Seven Sections of..255
Explosives, Thawing, Methods of........153

F

Fences, Wire, Unclimbable 183
Filing Systems, City Engineer's Office, Providence, R. I. 15
Flooded Machinery, Restoring to Operation, Method of 225
Forms, Column 117, 165
Construction of, Building Work.........123
Coping Wall for Dikes.................... 68
Curb and Gutter 46
Girder for Building Construction.......165
Lock, Cost of 280
Metal Lagging for 96
Roof Slab, Building Construction.......166
Sewer, Metal 96
Slope Paving, Holland 211
Steel, Possibilities of 291
Traveling for Molding Concrete Pipe... 30
Wall, Cost of 46
Lumber Required for 2
Plank Holders for 2, 46, 83
Steel for Hollow 317
Wharf Foundation 2
Foundations, Bridge Pier, Construction of 50
Underpinning with Concrete Piles..97, 293
Fox, Henry H. 80
Frozen Ground, Trimming and Dressing.. 70

G

Gabelman, J. G. 193
Gages, Recording, Water Level 160
Water Level for Deep Wells...........105
Garbage, Average Sample, Method of Securing 171
Gas Producers, Cost of Operating Suction.323
Girders, Molding Concrete Separately, Cost of 166
Grader Work, Cost of.......................169
Gravel Washing Plant, Description of....292
Grinding, Cost in Tube Mills.............. 47

H

Hauling, Cost of, Earth in Carts.......... 57
Earth in Wagons 47
Holes, Cost of Digging for Poles......91, 139
Digging for Tree Planting............ 8
Excavation with Explosives, Cost of....223
Horses, Maintenance of, Cost in New York City 309
Hydrants, Tests of 382

I

Illinois Society of Engineers and Surveyors 63
Incompetence, Criminality of 219
International Brotherhood of Steam Shovel and Dredge Men 78
Iowa Association of Cement Users........ 68
Irrigation Works, U. S. Reclamation Service, Progress of 199

K

Koppel, Arthur 314

L

Lights, Contractors', Milburn Acetylene..172
Lock Gates, Cost of 282

Locks, U. S. Government, Arkansas, Cost of 278
Lumber, Protection, U. S., 1906.... 2

M

Manholes, Concrete, Cost of....352
Mattocks, Use of, Discussion on.... 48
Meter Box Cover, Cast Iron....184
Mining Gold Gravel, Cost of....225
Mortar, Cost of for 1,000 Brick....221
  Destruction of by Alkalies....376
  Strength of Reground 4

N

National Forests, Expenditures and Revenues, Various Countries 243
National Good Roads Congress....374
Natural Resources, Conservation of....375

O

Oiled Roads, Construction Methods, Jackson, Tenn. 314
    Kansas City, Mo. 60
    New York 265
    Rhode Island 181
    Summary of Practice....337
    Toledo, O. 128
  Cost of, Jackson, Tenn. 314
    Kansas City, Mo. 60
    Massachusetts 347
    New York 265
    Rhode Island 181
  Oil Used, Amount of, Kansas City, Mo. 60
    New York 265
    Rhode Island 181
Okey, F. M. 250
O'Rourke, D. J. 379

P

Painting, Cost of by Compressed Air....230
  Railway Bridges, Cost of....180
Panama Canal (See Canals).
Pavement Base, Cost of 195, 378
Pavements.
  Asphalt, Binder Course, for....193
    Cost of 86, 87, 194, 195
    Municipal Repair Plants 87, 321
  Breaking Up with Pile Driver.... 75
  Cost of, Representative American Cities.195
  Fillers for Brick and Block....360
  Petrolithic, Rolling Tamper for....198
  Stone Block, Cost of....243
  Wood Block, Cost of....137, 300
Paving Blocks, Creosote Oil Tests for....241
Paving Materials, Cost of in Representative Cities, in 1907....194
Pile Drivers, Detachable Leads for.... 50
  Retarding Effect of Hammer Rope, Tests of 107
Pile Protection, Concrete Lock Joint Pipe 98
Piles, Concrete in Wharf Work....364
  Inclined in Dock Construction....362
  Redriving Tests, Charles River Dam...115
  Treating, Cost of with Teredo Proof Paint 206
Pipe, Concrete, Cost of Molding....171
  Mechanics of, Subjected to External Pressure 232
  Submerged, Method of Laying....171
Pipe Line, Location of by Dip Needle....216
  Steel, Stopping Holes in....372
Plank Holders, Dietrichs, for Wall Forms 83
  Farrell for Wall Forms....46
  Sullivan for Wall Forms.... 2
Plastering, Concrete Surfaces, Syracuse University Stadium 175
Poles.
  Concrete, Cost of 129, 151
    Examples of 66, 129, 151
    Tests of Strength 67
Pole Line Construction, Reinforced Concrete, Discussion of.... 65
Posts, Concrete for Marking Corners....225
Potter, Alexander 155
Power Plants, Life of....207
Puffer, F. E. 86
Pumps, Centrifugal, Power Consumed by.164

R

Rails, Relaying, Gang Organization for.. 51
Railways.
  Ceylon, Mileage of 29
  Cost of, Great Northern....271
    Northern Pacific 225
  Street, Rebuilding, San Francisco....150
    Track Construction, Rubble Concrete for 152
Reinforcement, Column, Hooped for....189
  Continuity of Necessity of....134
  Loose Bar and Unit Frame, Advantages Compared 186
  Placing, Cost of 300
Reservoirs, Cleaning, Method of....300
  Concrete, Cost of, Pomona, Cal. 220
Retaining Walls, Concrete, Cost of.... 16
Ritchie, James 190
Road Drags, Construction of....340
Road Oils, Analyses of....182
Road Rollers, Maintenance, Cost of....358
Roads.
  Adobe, Construction of....252
  Construction in Gumbo Soil....252
  Construction to Resist Wear by Automobiles 351
  Dragging, Cost of 290
  Foundation Construction for Macadam.290
  Grading, Cost of in Winter....126
  Macadam, Cost of, Easton, Pa....357
  Materials Required, Table for Estimating 141
  Object Lesson, Cost of....143
  Oiled (See Oiled Roads).
  Protection from Tides Method of....323
  Sand-Clay, Cost of 241
  Subgrades, Method of Preparing....148
  Yukon Territory, Cost of.... 62
Road Work, Daily Report Cards for....300
Rock Crushers, Oiling, Importance of.... 72
Rock Excavation, Grab Buckets for.... 70
Rolling Tamper for Petrolithic Pavement.198
Roof Slabs, Concrete, for Vault.... 15
  Molding Concrete Separately, Cost of...166
Roof Trusses, Studies of, Univ. of Ill....158

S

Scouring Velocities of Water for Various Materials 300
Scrapers, Ditch Cleaning 290
  Unloading Barges with.... 75
Scraper Work.
  Cost of, Comparison of Wheel and Drag Scraper 138
    Steam Scrapers 128
  Steam for Handling Klondike Tailings.128
Sewage Purification, Data on at Providence, R. I. 372
  Ohio State Law Governing....270
  Sludge Disposal 372
Sewers, Construction of 10-in. Under 8-in., Method of....216
  Contract Labor Costs, Providence, R. I. 75
  Estimate of Cost, Table for....200
  Forms for (See Forms).
  Outfall, Novel Construction of, Chicago.269
  Pipe, Quicksand, Cost of....341
    Rock Excavation for....350
  Plank Underdrain Construction for....105
  Trenching with Potter Trench Machine. 69
  Trenching with Steam Shovels....129
  Tunnel Construction for, Cleveland, O. 6
Shafting, Supports for During Reconstruction of Factory Building.... 54
Shaft Sinking.
  Cost of, Rand Collieries....168
    Rock, Goldfields, Nev. 138
  Drilling for, Machine vs. Hand....161
  Method of, Quicksand....105
    Rand Collieries 167
  Water Power Drills, Method of Using..235
Sheet Piles, Steel, Jackson.... 49
Sheet Piling, Driving by Hand, Method of 180
  Steel for Cofferdam, Cost of....357
Shoveling and Casting Eearth, Cost of... 58
Sidewalks, Specifications for Cement.... 90
Silos, Concrete Block, Construction of.... 2
Slide Rule, Hall, for Structural Steel Designing 206
Slope Paving, Concrete, Method of Constructing in Holland....210
Snow Removal, Economics of....147
Sounding, Wire Sweep Method for Shoals.216
Spade, Surfacing for Concrete.... 46
Specifications, "Approximate Estimate," Meaning of 154
  Poorly Drawn, Example of.... 41
Spreading Earth, Cost of....249
Steam Shovels, Browning Engineering Co.'s New Style....222
Steam Shovel Work.
  Cost of, Belle Fourche Dam....169
    Cellar Excavation 222
    Panama Canal 32
Steel Work, Cleaning by Sand Blast, Cost of 230
  Painting by Compressed Air, Cost of...230
Stone Crushers, Loss by City Operation, Boston, Mass. 207
  Sizes of Stone Delivered, Diagram of Percentages 192
  Traveling Plant, Street Railway Work..151
Streams, Scouring Velocities of....300
Street Cleaning.
  Cost of, Minneapolis, Minn.... 75
    Rochester, N. Y. 243
    St. Louis, Mo. 51
  Lost Time in Boston, Mass. 41
Street Dust, Characteristics of....313
Streets, Cost Keeping System for Improvement Work 360
  Oiled (See Oiled Roads).
  Specifications, Suggestions Asked for...141
Street Sweeping, Cost of, New York City.267
Stumps, Blasting, Cost of....294, 336
  Grubbing, Methods of....176, 213
Sub-Floors, "Tar-Rok," Method of Laying 373
Surveys, Geodetic Permanent Marks Used.200
  Land, Cost of....241
  Railway, Cost of....117
  Relocating Curved Boundaries, Tables for 301
  Tunnel Alinement, Erie R. R. 157

T

Tank, Moving, Method of....171
Telephone Equipment, Life and Depreciation of 105
Telephone Lines, Construction of, Methods of and Cost....324
Telephone Systems, Specifications for....145
Test Borings, Cost of....71, 148
Testing Laboratories, College, Practical Service of 243
Tests, Bond of Steel with Concrete.... 5
  Cast Iron and Reinforced Concrete Culvert Pipe 232, 244, 257
  Cement Drain Tiles 174
  Concrete Block, Recommended....137
  Creosote Oil for Paving Blocks....241
  Hammer Drills 223
  Hooped Concrete Columns 327
  Hydrants 382
  Mortar, Reground 4
  Redriving Piles, Charles River Dam....115
  Retarding Effect of Pile Driver Hammer Rope 107
  Roof Trusses, Univ. of Ill. 158
  Strength of Reinforced Concrete Poles..67
Ties, Cost of Producing by Plantations...241
Track, Cost of Street Railway....152
Traction Engines, Steam Shovel Attachment for 235
Transmission Line, Construction, Methods of 12
  Cost of 14, 91
  Poles for, Concrete.... 66
Tree Growing, Cost of....241
Tree Planting, Cost of.... 8
  Directions for 148
  Methods of 8, 252, 358
Trenches, Reinforced Concrete Slab Cover for 252
Trench Excavation, Cost of, Steam Shovel Work 129
Trench Excavators, Buckeye Traction...103
  Van Buren, New Type....310
Trenching.
  Cost of, Buckeye Traction Ditcher....103
    Electrical Conduits, Baltimore, Md...154
    Potter Trench Machine 69
Trench Machine, Potter, Cost of Trenching with 69
Trestles, Cost of, Hints on Estimating....104
  Materials in, Formula for Estimating..104
Tube Mills, Cost of Grinding in.... 47
Tunnel Excavating Machine....337
Tunnel Excavation, Earth, Cost of.... 6
  Rock, Methods of 9
Tunneling, Progress in Rock.... 11
Tunnel Intake, Connecting with Lake Bottom 39
Tunnel Lining, Concrete, Cost of....290
  Concrete and Brick, Cost of....6, 342
  Steel Centers for 124
Tunnels, Excavating Machine for....337
  Hudson River, Opening of....131
  Mine, Cripple Creek, Colo. 9
    Transvaal 11
  Sewer, Cleveland, O. 6
  Splugen, Italy 49
  Stampede, Cost of 342
  Survey for Alinement 157
  Water-Works, Detroit, Method of Construction 190
  Water-Works Intake 39
Tunnel Timbering, Methods of in Earth.. 6

U

Underdraining, Method of for Basement..171
Underground Conduits, Construction, Methods of Baltimore, Md. 201
  Cost of, Baltimore, Md. 201
Unloading Chute, Cars to Wagons.... 34

V

Viterbo, L. R. 5

W

Wages, Excavating and Loading Earth.47, 57
  Panama Canal 33
  Paving Work in Representative Cities in 1907 194
  Sewer Trenching 70
  Tunnel Work, Cleveland, O. 7
  Wheel Scraper Excavation.... 59
Wagons, Hauling in, Cost of.... 47
Wason, L. C. 108
Water Jets, Increasing Speed of Drilling by Use of 84
Water Mains, Protecting from Freezing, Method of 241
  Submerged, Cost of Laying....238
Water Powers, Value of, Computing Methods 73
Waterproofing, Drainage and Design in.. 29
  Felt and Bitumen, Directions for Applying 72
  Methods of Brick Aqueduct....171
Water Rates, Collecting, Unique Method of 41
Water Purification, Ohio State Law Governing 270
Water Supply, Deep Well, Copenhagen...373
Waterways, Inland, Commission Report..149
Wells, Shooting, Methods of....372
Western Society of Engineers, New Rooms for 370
Wharf, Foundation, Concrete 2
Wheelbarrows, Loads, Average, Test Determinations of 221
Wheel Scrapers, Excavation by, Cost of 59, 102
Wire Rope Tramways, Characteristics of..253
Worden, C. A. 348

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
$2.00 a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.
$2.50 a year (52 issues) to Dominion of Canada.
$3 00 a year (52 issues) to all other countries.
ADVERTISING RATES sent on application.

Entered as second-class mail matter at the Post Office at Chicago, Ill.

CONTENTS

EDITORIAL:
A Word from the Publisher Telling of the Plans for 1908. . . . 1
CONCRETE SECTION:
Concrete Block Silo Construction...... 2
A Method of Constructing Wall Forms Without Studding or Bracing....... 2
Method and Cost of Constructing a 70-ft. Reinforced Concrete Arch Bridge 3
Hydraulic Properties of Reground Cement Mortars...... 4
Tests of Bond Between Plain Bars and Concrete 5
EARTH AND ROCK SECTION:
Method and Cost of Driving a Short Tunnel for a Sewer.......... 6
Cost of Digging Holes and Planting Trees and Shrubs.......... 8
Method of Drilling and Marking a Rock Tunnel.......... 9
GENERAL ARTICLES:
Methods and Cost of Transmission Line Construction..........12
Methods and Costs..........15
Systematic Analysis of Cost Data.....16
Practical Suggestions on Computing...16
ENGINEERING LITERATURE INDEX SECTION.19

A Word From the Publisher Telling of the Plans for 1908.

In this issue appears, for the first time, a section entitled Index to Civil Engineering Literature. This index gives reviews of all important articles, bulletins and papers of interest to civil engineers and contractors. The Index will be a feature of our first issue in each month.

Engineering-Contracting has come to be known as the "methods and cost" journal, because one of its specialties has been its articles giving the itemized costs of work and structures, accompanied by descriptions of methods and machines used. It will continue to be the "methods and cost" paper, but, as indicated in the appearance of the Index, the field of Engineering-Contracting will be broadened so as to cover completely all branches of civil engineering, as well as contracting for works designed by civil engineers. It was predicted eighteen months ago by several skeptical readers that it would be impossible for the editors of Engineering-Contracting to continue giving articles containing cost data, for, it was urged, the supply of cost data would soon become exhausted. Those who made the prediction will, I am sure, be glad to record themselves as false prophets. For two years Engineering-Contracting has not produced a single issue that did not contain at least one good article on costs, and the great majority of issues have had several such articles. Besides this I may add that our editors have accumulated a great fund of cost data hitherto unpublished and that not a week passes without contributed data coming to our offices.

During the year 1907 we bought Engineering World and incorporated it with Engineering-Contracting, thus adding materially to the number of our readers, and at one stroke placing the circulation of Engineering-Contracting far ahead of any engineering or contracting journal published outside of New York City. I estimate that there are not fewer than 60,000 civil engineers and contractors in America. No single periodical has more than about 20 per cent of this number on its subscription list. I aim to secure at least 50,000 subscribers for Engineering-Contracting, and I am satisfied that it can be done merely by a steady development of our present plans. Our Earth and Rock Section has already served to add not fewer than 2,000 new subscribers, most of whom are railroad contractors and public works contractors whose specialty is excavation. When these contractors learned that this section was to be in the hands of Halbert P. Gillette and Daniel J. Hauer, two men having wide personal experience as contractors in this class of work, there was an immediate response in the form of subscriptions, and there continues to be a steady addition every week from this source.

Thus far we have developed only two special sections in Engineering-Contracting, the one just mentioned, which is devoted to methods and cost of earth and rock excavation, and the one devoted to concrete. Now we have added the Civil Engineering Literature Section, and we purpose adding a Municipal Section early this year. Up to the present time all our articles on municipal work, and on road work, and there have been a large number of them, have appeared in the general section of the paper. But, as soon as our advertising patronage will warrant the expense, a Municipal Section will be established.

With an editorial staff already as large as that of our largest contemporary, with a great field of readers in the South and West practically untouched by any of our contemporaries, with a universal field of possible readers reached only in part by all of our contemporaries and our own paper included, I regard the possibilities of growth in our circulation during 1908 as being limited only by the rapidity with which I can secure new advertisers. Advertising income must keep pace in some measure with circulation, or circulation must be checked. Indeed my greatest worry during the past two years has arisen from the fact that the growth in our subscriptions has always been so much more rapid than the growth in advertising. This was to be expected, of course, but it was not the less a cause of worry, particularly when I realized that I would have to raise the subscription price to an absolutely prohibitive rate if ever I were to see advertising growth keep step with growth in circulation. I decided, however, to publish Engineering-Contracting at a loss, if need be, rather than do anything to throttle its circulation, and I am of that decision still.

Some time ago I announced a special subscription offer, whereby present subscribers might renew their subscriptions for not to exceed five years at $1 a year. I offered also to accept new subscriptions on these same terms, $1 a year, or $5 for five years, for domestic subscriptions, $2 to Canada and $2.50 a year to all other countries. This is just one-half the regular price of Engineering-Contracting, and my offer has been met with a hearty response from subscribers in every section of the country. A large number have subscribed for five years, while others have improved this opportunity to secure clubing lists. One professor of civil engineering in a leading university has sent us the subscriptions of 24 members of his senior class. A large number of our subscribers have sent us 10 to 20 new subscriptions each, while still others have favored us with the names of friends to whom they requested us to send sample copies. I appreciate very much this co-operation on the part of the readers of Engineering-Contracting, and at the request of a number of friends have decided to extend this special subscription offer through the month of January.

I have already mentioned the quality of the matter that we print, and have stated that the quantity will be increased to keep pace with our growing advertising patronage. I firmly believe that Engineering-Contracting excels every competitor in the value of its reading matter, and that there is a market for this excellence. I believe, also, that "hard times"—if we are to have them, which I doubt—will prove hardest for him who slackens his efforts to build up his business.

Myron C. Clark,
Publisher.

Copyright, 1907, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Concrete Block Silo Construction.

A method of constructing concrete block silos, with some figures of cost, is described briefly in a paper read by Mr. H. E. Murphy at the recent convention of the Northwestern Cement Products Association. We quote the following portions of the paper:

"We procured a set of circular plates, and by altering slightly the cores of the block machine we were using equipped ourselves with an outfit. We mold our blocks circular in form, so that when laid in the wall they make a true circle without any cutting or fitting. Along the outer edge of the top of the block we put a ½-in. groove, in which we put a steel wire or band to assist in taking up the lateral pressure when the silage is settling.

The diameter of a silo depends, of course, on the capacity desired. It is better to increase the depth rather than the width within certain limits, for two reasons: Increased depth gives greater pressure and closer packing, resulting in a more thorough exclusion of the air. Then a silo should be so calculated that the surface will be fed off each day. For when the silo is once opened the top is, of course, exposed to the air and spoils rapidly. However, when a very large capacity is desired, it is better to increase the diameter slightly, as a small increase in diameter gives a comparatively large increase in cubical contents, and thus reduces the ratio between the cost and the contents. The average size silo that we build is 14 ft. 6 ins. inside diameter and 30 ft. high.

The construction of a silo of cement blocks is simple. The foundation is built very cheaply of field-stone, or preferably of concrete. Where concrete is used and the soil will permit, no form is required. We excavate a circular trench and fill it with concrete, and when the concrete sets, remove the earth from the center. The blocks are laid in the same manner as in an ordinary building, except that steel wire bands are put in the grooves at about every third course. A silo is usually built with a door up the entire height to allow for the removal of the silage as it is taken off the top. Across this opening we put ⅝-in. rods which are tied with the steel wire about 1 in. from each side. This provides a good ladder and strengthens the wall.

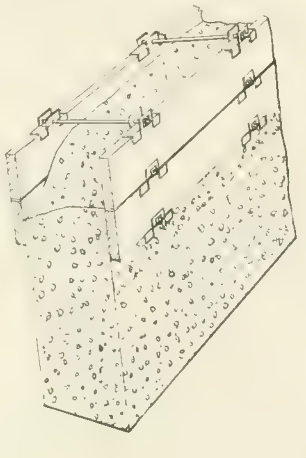
We use no door frames, but make a special jamb block notched to receive a 2-in. plank, which is put in place as the silo is filled and held in position by the pressure of the silage. This provides a cheap but good door, and there is no frame to rot away. As the planks rot they can be replaced at very little trouble and expense.

It is well to plaster the inside of the silo with a ½-in. coat of cement plaster finished as smooth as possible, as the acids of the silage attack the lime in the joints. This plaster also makes the walls smooth enough to allow free settling of the silage and covers up defects in the workmanship of the masons.

The cost of laying blocks, using of course country masons, runs from 2½ cts. to 4 cts. a block, the block being 24 ins. long, 8 ins. high and 9 ins. thick. This is for labor alone, the cost of mortar being the same as for any other form of block building."

A Method of Constructing Wall Forms Without Studding or Bracing.

In building long stretches of concrete wall the use of sectional or movable forms usually makes possible a material reduction in the amount of form lumber required. These sections of forms may be of any size convenient to shift with the machinery at hand. In our issue of February, 1906, we described a form for retaining wall construction in which the panels or sections were 51 ft. long and 20 ft. high and were shifted by means of locomotive cranes. In the accompanying cut we show a method of sectional wall form construction in which a section is a single plank and all shifting is done by hand. The essential feature of this form construction, however, is that all studding and bracing usual in wall forms is done away with by using a special plank holder and wall form tie. These plank holders are made of soft steel plate cold pressed to the shape shown for straight wall work and to special forms for corners and other special work. The tie bolts are pressed through the wall in the usual manner and are provided with sleeves to permit withdrawal. Mr. J. H. Sullivan of Grand Rapids, Mich., is the inventor and manufacturer of these plank holders.



Sectional Wall Form Construction.

In using this plank holder the mode of procedure is to work in horizontal courses one plank high around the wall, running the bottom plank and placing it on top as each new course is begun. As an example of actual work we have a record of a building 100 x 54 ft. in plan and 36 ft. high with 12-in. walls. A height of two 12 x 2-in. planks entirely around the building was all the form work required at any one time so that the amount of form lumber required for the building was 2,464 ft. B. M., plus 205 ft. B. M. of 2 x 4-in. flooring strip or altogether 2,669 ft. B. M., or 0.24 ft. B. M. per sq. ft. of exterior wall surface or 6½ ft. B. M. per cu. yd. of concrete. This same form lumber, with 16 additional plank, was then used to construct a building 100 x 100 ft. x 16 ft. high so that some 3,000 ft. B. M. of form lumber sufficed for 17,548 sq. ft. (exterior surface) of wall or for 617 cu. yds. of concrete in 12-in. wall, which gives 0.17 ft. B. M. per sq. ft. or 4.8 ft. B. M. per cu. yd. of concrete.

The granite masonry of a dock rests upon a concrete footing, the latter being laid upon a rock foundation, which lay at a depth of 14 to 19 ft. below mean low tide. The concrete was placed in forms built up from the rock the length of the dock on the front face of the footing, and where necessary on the rear face. These forms were made in sections 16 ft. long, the face of the form being 2x10-in. plank nailed longitudinally to 2x10-in. verticals. In order to hold the forms firmly to the bottom, a box was made on the outside of the form by nailing a horizontal plank on the bottom and then a second vertical row of longitudinal 2x10-in. plank. Broken stone was then placed in this box. In addition the forms were anchored by wire cables near the bottom to some old piles, and they were also braced in position at the top by cross pieces nailed to the stringers of an old dock.

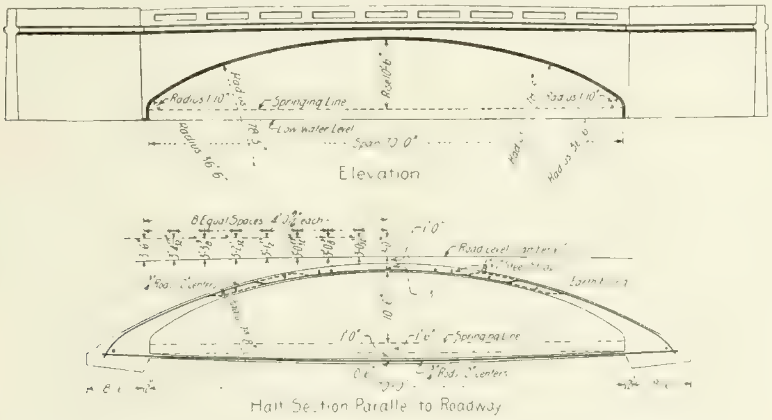
In 1906 the value of the reported lumber production in the United States amounted to $621,151,388.

A trial consignment of volanic ash, for use in cement and concrete work, has been sent from Moji, Japan, to San Francisco to ascertain the prospects of a market for the article in the United States.

Method and Cost of Constructing a 70 ft. Reinforced Concrete Arch Bridge.*

The bridge has a span of 70 ft. and a rise of 10½ ft., with a 16-ft. roadway, two 4-ft. sidewalks and a total width of 25 ft. The construction is shown clearly by Fig. 1. The arch is of the Luten type designed by Mr. Daniel B. Luten and built exclusively by the National Bridge Co., of Indianapolis, Ind. These arches are unique in that they make use of a pavement of reinforced concrete under the stream, the reinforcing rods of this paving being hooked into the corresponding rods in the arch ring thus forming a complete ring of reinforcement. By this means the reinforcing rods in the paving take the thrust of the arch and the abutments may be made very light.

The work was begun by removing an old bridge. This done, excavations for the abutments were dug, drag scrapers being used wherever it was possible, since room was rather limited. Some of the material excavated was clean gravel and was laid aside to be used in the concrete.



Elevation and Half Section of 70 ft. Concrete Bridge.

In laying the 6-in. pavement, temporary dams of rocks and puddled earth were built and the entire stream diverted to the south half of the channel, leaving the north half dry. The concrete was mixed in the proportions of 1 part of Iola Portland cement to 7 parts of creek gravel, containing considerable sand, which was hauled from a bar in the creek several hundred yards below the work. Mixing for pavement concrete was done by hand, being turned twice without the addition of water. It was then shoveled off the mixing platform into the excavation, which contained enough seepage water to wet the concrete. When 3 ins. of concrete had been laid, the reinforcing bars, extending entirely across the stream, were put in place, and were covered with 3 ins. more of concrete. The reinforcing rods are of Bessemer steel, ¾ in. in diameter, and were welded together to form rods 86 ft. long. In the paving there are 26 of these rods spaced 12 ins. c. to c.

When the north half of the pavement had been finished, the stream was diverted to that side of the channel and the pavement for the south half laid in the same manner. Some difficulty was experienced in laying the paving owing to the fact that the stream, swollen by long continued rains, several times broke through the dams and covered the newly laid concrete with sand and mud.

After the paving had set sufficiently to carry the load of the centering, forms for the arch ring were erected, the 2 x 8-in. posts resting directly upon the paving concrete. These posts were spaced 10 ft. apart and were braced by 1 x 6-in. boards. Upon these posts rested the plank centers, cut from 2 x 12-in. planks to the shape of the arch, and covered with a lagging of 1 x 6-in. tongued and grooved flooring, dressed and carefully laid, so as to present as smooth a surface as possible.

The concrete for the arch ring was mixed in the same proportion as that for the paving, but in this case a screw mixer was used, the motive power being furnished by a steam road roller, blocked in place and belted to the mixer. Concrete was dumped from the mixer into the wheelbarrows, wheeled on runways out over the arch forms and dumped. Only half the width of the arch ring was placed at once, as this was all that could be placed in one day. Work was commenced at both ends of the arch and carried toward the center, all mixing, however, being done on the north bank.

The reinforcement for the arch ring consists of 26 rods 92 ft. long, spaced 12 ins. c. to c. The rods follow the shape of the intrados for some distance from the crown, and then are bent to follow the shape of the extrados for the remaining distance. No two consecutive rods are bent at the same point, but all are bent at one of three points, as shown in the figure. These rods are hooked over the ends of the rods in the pavement as explained above. In addition to these longitudinal rods, there are seven transverse rods over the crown and two other transverse rods, one near each abutment. Also, three straps ⅛ x 1 in., are placed transversely of the arch near the crown.

Upon completion of the arch ring, the forms for the spandrel and wing walls were placed and the concrete dumped into place from wheelbarrows. All stones were forced away from the faces of the walls by means of a shovel.

Each wing wall is reinforced with three steel rods, ¾ in. in diameter, placed vertically and two similar rods placed horizontally. In addition, the two rods in the hand rail are continued to the ends of the wing walls, making rods 152 ft. long. The two wing walls at each end of the span are tied together by a ¾-in. steel rod. The spandrel walls are reinforced with six vertical rods ¾ in. in diameter, in each wall on each side of the center of the arch, these rods being spaced closer together near the abutments and farther apart near the crown.

As soon as the concrete in the spandrel walls had set sufficiently, the forms were removed and the earth filling hauled in and compacted. The centering for the arch was struck after 30 days. The arch, when visited in March, 1907, nine months after completion, showed only a few small temperature cracks.

The various items of cost in the construction of this arch were as given below. In this table, the depreciation on plant and tools was estimated by the writer to be about $100, which is probably not far from correct.

Item	Cost.	Proportion of total cost in per cent.
Removing old bridge	$ 144.00	2.86
Excavation	200.00	3.98
Lumber	480.00	9.56
Steel for reinforcement, 9.000 lbs. at $0.041	370.00	7.37
Cement, 390 bbls. at $2.525	1,015.00	20.21
Gravel, 470 yds. at $0.67	315.00	6.27
Concrete labor, including placing of steel	360.00	7.16
Welding steel	40.00	0.80
Erection of forms	310.00	6.17
Removing forms and back filling	286.28	5.70
Sidewalks	135.00	2.68
Freight on tools, Indianapolis to Boulder and return	227.16	4.52
Supervision	415.00	8.26
Miscellaneous	159.06	3.16
Depreciation (estimated)	100.00	1.99
Contractor's profit	468.50	9.31
Contract price	$5,025.00	100.00

The reported lumber production of the United States in 1906 was 37,550,736,000 ft.

---

*Condensed from an article by Howard C. Ford in "The University of Colorado Journal of Engineering" No. 3, 1906-7, published by the Associated Engineering Societies of the University of Colorado, Boulder, Colo.

Hydraulic Properties of Reground Cement Mortars.*

Observing in the course of our microscopic examination of cement mortars that a large proportion of the cement was unacted upon by water even after submergence for long periods, we decided to determine by actual test the extent of the hydraulic properties remaining in the cement after it had been gauged with water and allowed to harden. Having in the course of our regular routine cement testing, occasion to sample and test a large amount of one brand of cement, we determined to try the experiment on the broken neat briquettes from the seven and twenty eight day tests of this cement.

The original cement, a well known standard American brand, was sampled in carload lots, the sample being collected between July 17 and Sept. 16, 1905, and represented several thousand barrels. Each car was tested separately and all passed the requirements of the American Society for Testing Materials. In order to arrive at a standard of comparison, the results of the individual tests of the cars was averaged, giving the following as the mean of the different tests:

Fineness: 91.5 per cent. passed a No. 100 sieve and 76.2 per cent. passed a No. 200 sieve.

Setting time, as determined by Gilmore's needle: initial set, 170 minutes; final set, 334 minutes. Percentage of water, 21.

Soundness or constancy of volume: cold water pats, good; air pats, good; steam pats, good.

Specific gravity, 3.14.

Average tensile strength of standard briquettes: neat, 710 lb. at 7 days and 778 lb. at 28 days; 1:3 mortars, at 261 lb. at 7 days and 360 lb. at 28 days.

As a further check an average sample was prepared from the various samples collected taking the same amount of cement from each sample and mixing thoroughly. The sample so prepared was tested in accordance with the standard specifications and gave the following result: Silica, 21.25; alumina and iron oxide, 11.09; lime, 62.96; magnesia, 2.35; sulphuric anhydride, 1.23; loss on ignition, 74; total, 99.12.

TENSILE TEST, STANDARD BRIQUETTES (AVERAGE OF FIVE BRIQUETTES.)

Neat.	Lbs.	1-Cement, 3-Sand.	Lbs.
7 days	610	7 days	182
28 days	754	28 days	338
3 months	754	3 months	487
6 months	640	6 months	415
9 months	[illegible]	9 months	350
1 year	[illegible]	1 year	322
2 years	[illegible]	2 years	325

The lower tensile tests obtained at the seven-day period can be accounted for by the cement having been exposed to air and aged considerably before the average sample was made up. For this reason no test for setting time or specific gravity was made on the average sample.

In addition to the standard sieving tests the percentage of flour in the sample was determined by elutriation.

Percentage of cement passing 100-mesh sieve, 91.40.

Percentage of cement passing 200-mesh sieve, 76.30.

Percentage of cement remaining in suspension in dry kerosene after 30 seconds settling, 45.18.

Percentage of cement remaining in suspension in dry kerosene after 2 minutes settling, 29.85.

The broken neat seven and twenty-eight day briquettes made from the individual samples were saved, being stored in air in the cellar. After a sufficient quantity had accumulated they were dried at a temperature of 212° F. until of constant weight, then crushed and reground in a laboratory tube mill. The resultant product ,when tested as cement in accordance with the standard specifications gave the following results:

Fineness: 94.4 per cent. passed a No. 100 sieve; 74.4 per cent. passed a No. 200 sieve.

Setting time as determined by a Gilmore's needle: initial set, 60 minutes; final set, 310 minutes. Percentage of water, 25. Temperature of water, 62° F. Temperature of air 66° F.

Specific gravity, 2.57.

Soundness or constancy of volume: cold water pat, good; air pat, good; steam pat, good.

TENSILE TEST, STANDARD BRIQUETTES (AVERAGE OF FIVE BRIQUETTES.)

Neat.	Lbs.	1-Cement, 3-Sand.	Lbs.
7 days	123	7 days	26
28 days	253	28 days	63
2 months	340	2 months	145
3 months	383	3 months	179
4 months	402	4 months	227
1 year	401	1 year	198

The neat briquettes from the above test were in turn kept, being stored in air of cellar. On completion of the test, these were dried, reground and tested in the same manner as before, but the resultant cement was in addition analyzed. The results of the analysis after being twice gauged with water, were: Silica, 17.60; alumina, 5.67; iron oxide, 2.29; lime, 49.64; magnesia, 1.66; sulphuric anhydride, 1.13; water, 17.90; carbon dioxide, 3.84 = 8.27 $CaCO_3$.

The physical tests after three gaugings with water were as follows:

Fineness: 93.8 per cent. passed a No. 100 sieve and 73.6 per cent. passed a No. 200 sieve.

Setting time determined with a Gilmore's needle: initial set, 240 minutes; final set, 24 hours. Percentage of water, 26. Temperature of air, 73° F. Temperature of water, 70° F.

Soundness or constancy of volume: cold water pats, good; air pats, good; boiling pats, good.

Specific gravity, 2.35.

TENSILE TESTS, STANDARD BRIQUETTES (AVERAGE OF THREE BRIQUETTES.)

Neat.	Lbs.	1-Cement, 3-Sand.	Lbs.
7 days	71	7 days	17
28 days	103	28 days	73
2 months	182	2 months	82
3 months	220	3 months	118
4 months	235	4 months	132
5 months	250	5 months	148

To confirm these results a similar test was made on another brand under conditions in all respects identical, with the following results:

Fineness: 96.3 per cent. passed No. 100 sieve, and 80 per cent. passed No. 200 sieve.

Setting time by Gilmore's needle: Initial set, 133 minutes; final set, 377 minutes. Percentage of water, 25. Temperature of water, 62° F. Temperature of air, 66° F.

Soundness or constancy of volume: cold water pat, good; air pat, good; steam pat, good.

TENSILE STRENGTH WITH STANDARD BRIQUETTES.

Neat.	Lbs.	1-Cement, 3-Sand.	Lbs.
7 days	735	7 days	265
28 days	837	8 days	407

The test results obtained after regrinding the neat briquettes from the above cement were as follows:

The analysis of cement after the first gauging was: Silica, 19.88; alumina, 4.53; iron oxide, 2.03; lime, 55.30; magnesia, 2.64; sulphuric anhydride, .89; carbon-dioxide, .68; water, 13.68.

Fineness: 97.1 per cent. passed a No. 100 sieve and 78.5 per cent. passed a No. 200 sieve.

Setting time by Gilmore's needle: Initial set, 209 minutes; final set, 434 minutes.

Soundness: Cold water pat, good; air pat, good; boiling pat, good.

Specific gravity, 2.56.

TENSILE TEST, STANDARD BRIQUETTES (AVERAGE OF FIVE BRIQUETTES.)

Neat.	Lbs.	1-Cement, 3-Sand	Lbs.
7 days	192	7 days	57
28 days	343	28 days	181
2 months	365	2 months	238
3 months	405	3 months	278
4 months	410	4 months	281
5 months	382	5 months	293
6 months	440	6 months	322
7 months		7 months	

These experiments clearly show that even after cement has been twice gauged with water and allowed to harden under water, that all the cementing and hydraulic qualities are not destroyed, and that gauging with water and submergence in water does not retard the setting time of the reground cement as much as would be expected. Indeed, in the first test the setting time of the cement on being reground was quicker than in the original shape. A third conclusion is that it is only the very fine flour in the cement that is in condition to react when gauged with water and give strength to the mortars.

---

*Extract from a paper presented at the annual convention of the Association of American Portland Cement Manufacturers by Henry S. Spackman and Robert W. Lesley.

Tests of Bond Between Plain Bars and Concrete.

BY L. R. VITERBO.*

These tests were made at the testing laboratory of the Washington University for the Reinforced Concrete Construction Co., of St. Louis, Mo., who were acting by request of the Board of Appeals of the building department of the city. The tests were performed under the direction of Prof. J. L. Van Ornum, M. A. S. C. E., of the civil engineering department of the university, and were witnessed by a number of engineers, architects and contractors.

By mutual understanding between the engineers of the building department, the engineers of the Reinforced Concrete Construction Co. and Prof. J. L. Van Ornum, it had been agreed that a series of five tests should be made on medium steel bars, and another series of five tests should be made on high carbon steel bars. The bars used were round, and of the following diameters: ½ in., ⅝ in., ¾ in., 1 in., and 1¼ ins. They were embedded in concrete prisms, the cross section of which was uniform for all tests and 12"x12". The lengths of embedment were 25 times the diameter of the bar tested for the medium steel, and 40 times the diameter of the bar tested for the high carbon steel (with one accidental exception). The concrete was a 1-2-4 Red Ring cement, Mississippi river sand and gravel, moderately wet mix.

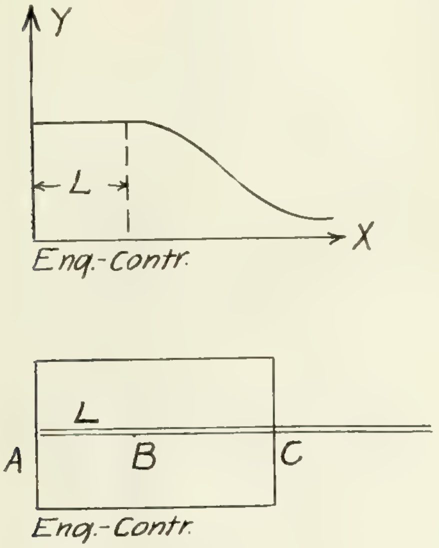


Fig. 1.

The bars were embedded in the concrete on Aug. 30, 1907. The wooden forms were removed from the prisms after six weeks, and the bonding tests were made 90 days after the bars had been embedded in the concrete—viz: Nov. 29 and 30, 1907. These tests have set forth the following facts of interest.

(1) On every one of the bars tested, the first slip occurred shortly after the elastic limit of the steel had been reached, which tends to show regardless of any figures, that the bond between a plain bar and the concrete in which it is embedded, is fully developed until the elastic limit of the steel is reached, then the steel begins to stretch and the bond is slowly destroyed from one section to the other.

(2) That after the bond proper had been destroyed there still remained a considerable friction.

(3) That the maximum bond obtained per square inch of surface in contact was 460 lbs. on medium steel, the minimum being 370 lbs. That the maximum bond obtained per square inch of surface in contact was 470 lbs. for high carbon steel, the minimum being 330 lbs.

TESTS OF BOND BETWEEN PLAIN ROUND BARS AND 1-2-4 GRAVEL CONCRETE, MIXED WET

Physical properties of steel bars tested.								Pull resisted before slipping.				Friction after slipping had occurred	
Size of tested section, ins	Maximum load producing rupture.	Maximum strength in lbs per sq in	Limit of elasticity in lbs	Limit of elasticity in lbs. per sq. in.	Elongation of tested section	Per cent of elongation	Modulus of elasticity.	Length of embedment in concrete.	Surface of embedment, sq in.	Maximum pull in lbs	Max. pull in lbs. per sq in of embeded surface	Friction in lbs.	Friction in lbs per sq in.
							Medium steel bars.						
½"	12280	60200	8260	40500	2.13"	26⅝	29,900,000	13 8"	21 7	10050	460	7500	340
⅝"	18510	57500	12640	39300	2 30"	28¾	29,300,000	16.7"	32 8	14010	430	10100	310
¾"	24580	55600	17050	38600	2.32"	29	29,800,000	20 6"	48 5	18120	370	15980	330
1 "	45370	58900	29580	38400	1.91"	23⅞	28,600,000	25.7"	80 7	31110	390	30510	380
1¼"	75350	60900	48140	38900	1.80"	22½	29,800,000	32 3"	126 8	49300	390	45000	350
							High carb'n steel bars.						
½"	18710	88300	12280	57900	1.26"	15¾	29,200,000	20 8"	32.7	13120	400	6800	210
⅝"	27580	85700	17440	54200	1.46"	18¼	28,900,000	25 6"	50 3	18360	370	12000	240
¾"	48430	109600	26820	60700	1.10"	13¾	30,600,000	32 5"	76.6	29930	390	20600	270
1 "	76470	95500	42560	53100	1.56"	19½	29,700,000	32.7"	102.7	48260	470	29000	280
1¼"	101330	83900	65940	54600	1.66"	20¾	30 400,000	50.5"	198.3	66140	330	39320	200

(4) That higher values per square inch of the ultimate bonding stresses would have undoubtedly been obtained, had the lengths of embedment been shorted. In fact, the 1 in. bar of high carbon steel had been accidentally embedded in the concrete only 32.7 ins., instead of 40 ins., and the bond per square inch went up to 470 lbs., a higher value than any other one of the same series.

This fact tends to prove that there is very likely for a bar of a given diameter a certain length of embedment corresponding to a maximum value of the bonding stress per square inch of surface in contact, and taking that length of embedment for basis that the bonding stress per unit surface decreases when the length of embedment increases.

In other words, if a bar of a given diameter is given different embedments in a prism of concrete, if the embedments are plotted in abscissas, X, and if for each embedment is determined the bonding stress Y, and that these are plotted in ordinates, the resulting diagram would be as shown by Fig. 1.

These, of course, are purely theoretical assumptions, and it would be interesting to verify them by a series of experiments. Let L be the length of embedment corresponding to the maximum bonding stress per unit, then let us consider a prism of concrete in which is embedded a bar of diameter D, the fact that the bar begins to slip slightly after its elastic limit is reached, leads to believe that the length L produces anchorage of the bar in the concrete, and that the bar begins to stretch at or around the section B; the bar stretching from B to C, naturally its diameter decreases and therefore its bond between B and C is slowly destroyed; then the pull on the bar is sufficient to overcome the bond between the portion A B of the bar and the concrete, consequently the bar begins to slip.

Another interesting feature set forth by these experiments is the fact that after the bond proper has been destroyed, there still remains a considerable friction as mentioned.

As the allowable tensile stress on a bar is taken at 40 per cent of its elastic limit, if we assume an allowable safe bonding stress of 80 lbs. per sq. in. in contact, the fact that there still remained a friction of about 200 lbs. per sq. in. shows that the bond proper of 80 lbs. insures a safety of 40 per cent on the ultimate friction, should the bond have been prematurely destroyed.

---

*Columbia Building, St. Louis, Mo.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Method and Cost of Driving a Short Tunnel for a Sewer.

In a paper read before the American Society of Civil Engineers and published in the Transactions of the Society, Vol. lv., page 390, Mr. W. C. Parmley described the construction of the Walworth sewer at Cleveland, O. A short section of this sewer was built as a tunnel and Mr. Parmley has furnished us with the details of the cost of this portion of the work, which we give below. The following abstract describing the work is taken from the Transaction noted above:

"Where the sewer intersects the C., C., C. & St. L. Ry., it was planned and contracted for on the expectation that the railway would support its tracks over the trench upon temporary trestle work. On account of serious differences between the railway and the city it became necessary to build about 190 ft. of the sewer in tunnel. This tunnel proved to be one of the most difficult parts of the entire work.

"Under special resolution of the City Council a supplemental agreement was made, under which the contractor was to do the work for cost, plus 15% for profit and use of equipment. Accordingly, work was begun about August 9, 1900; it was completed on July 1, 1901.

"The length of the tunnel proper is 144 ft., with 16 ft. of open cut at the east end and 32 ft. at the west end, making a total length of 192 ft. The tunnel, as designed and built, is shown by Fig. 1, which, with only slight modification, was adhered to throughout.

"As soon as the pit at the east end had been sunk and a grillage in the bottom laid the work of tunneling was begun and carried on by ten-hour night and day shifts.

"The side tunnels were commenced about Sept. 5, and completed about Dec. 19, 1900. The ground penetrated was treacherous in the extreme, the surface of the ground water being near the springing line of the sewer. Above this level the material was a very fine dry sand, which required the closest lagging and bulkheading, as the work progressed. In fact, the sand sifted through the cracks in the planking so badly that in many places they had to be caulked with hay. Below the ground water level the soil changed more to a soft, silty substance which resembled wet quicksand and which, to prevent caving, required even greater precautions than the dry material above.

"The timbering used consisted of 10x10 in. sets with 2 in. lagging. The sets were spaced 3 ft. apart from center to center, and directly on the apex joints of the top drifts of the two side tunnels. Of course, care was taken to place the timbers of the side tunnels opposite, so that the timbers of the roof tunnel would come transverse to the center line.

"After the top heading of each side tunnel was driven in some distance the middle drift was carried forward, and still later, the bottom drift. As a rule, only one face in each side tunnel was worked at a time.

"The method of supporting the timbering of the upper headings while the next lower heading was being driven is of some interest. For example, the side struts for the top heading were carried on a 3x10 in. mud sill, the timber set appearing as in Fig. 2.

"Two methods were used for holding up the upper timbers, the first being as follows: A 10x10 in. cross brace was fitted between the lower ends of the side posts and immediately above the mud sill, and held down by heavy cleats at the ends. Longitudinal timbers were then slipped under the mud sill, the advance ends of the timbers being carried on the ground floor of the top drift and the rear ends upon jacks which rested on the floor of the lower drift. By turning up on the jacks the weight of the upper drift was carried entirely upon the two longitudinal timbers. The end of the mud sills were then sawed off and the next lower section of the side struts inserted and carried upon a new mud sill. The jacks were then removed and the 10x10 in. cross timber was driven down to cover the joint, as shown by Fig. 3. The finished appearance of the timber sets of the two upper drifts is shown in Fig. 4. The second method, and one which was adopted for most of the work, was superior to the one described, and is as follows: The longitudinal timbers were laid on top instead of under the mud sill. The advance end of the timbers, as before, rested upon the floor of the upper drift, and the rear ends were carried on the top of the cross brace of a completed bent of tunnel timbering. Chains were wrapped around the cross brace and timbers, and the weight was carried by wedging up under the chains. In this way two bents of upper timbers were supported. The method is illustrated in Fig. 5.

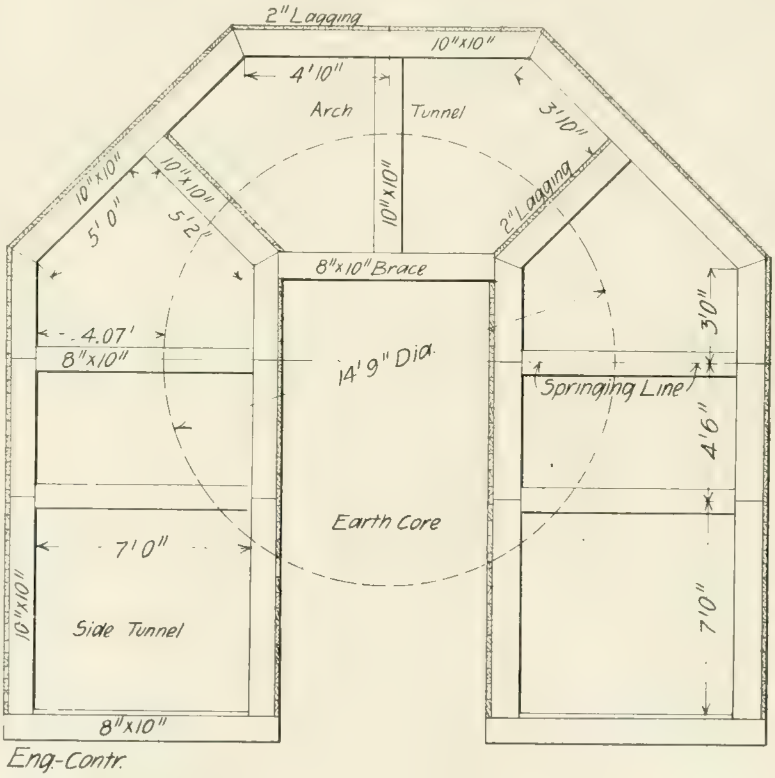


Fig. 1—Sketch Showing Method of Excavating and Bracing Tunnel.

"About midway in the tunnel an old stone culvert was encountered, which extended diagonally across the work. The culvert was supported upon a solid layer of transverse 12x12 in. oak timbers, with a flooring of 3x12 in. oak longitudinal planking. Old stumps were also frequently excavated. These were invariably very hard and sound. The old culvert and the stumps were a great annoyance and impeded progress seriously.

"The roof tunnel was driven after the side tunnels had been completed. Work on this drift was begun on Dec. 20, 1900, and finished Feb. 23, 1901. On account of the caving nature of the ground the face was bulkheaded in three parts—a middle and two side sections. The bulkhead for each of these sections was pushed forward about 3 ft. and braced in position. Only enough of the earth at the roof was mined out to allow the roof timber and the side inclined post to be set. In this way the roof was secured and the bottom part of the heading mined out in safety. As soon as the floor level was reached the middle prop was placed.

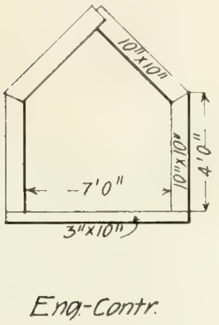


Fig. 2.

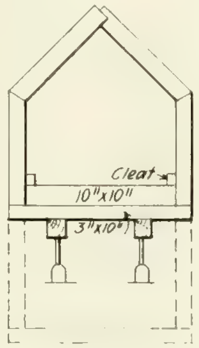


Fig. 3.

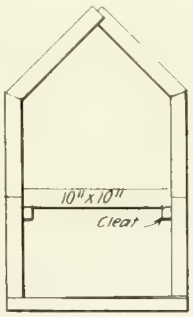


Fig. 4.

"The west open cut, lying at the foot of the railway embankment, was begun in January, 1901, and roofed over with planking. The broken stone and sand from the siding were shoveled through chutes from the cars directly upon the plank bottom of the excavation, where they were mixed and shoveled or wheeled into place. The large amount of timber bracing in the open cut and in the tunnels interfered greatly with the movements of the men, and some changes had to be made in the timbering, from time to time, to make passageways. The concrete for the side tunnels was wheeled in from the west end and packed tightly about all the timbering. That for the side walls was dumped from a planking laid along the floor of the upper drift of the side tunnels.

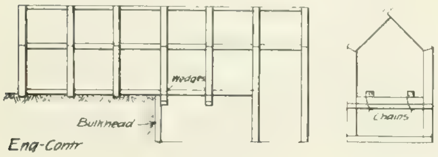


Fig. 5.

"The concrete sides were carried up to a radial plane 14° above a horizontal through the middle of the sewer. These planes inclined from the extrados of the arch downward and inward on a slope of 1 vertical to 4 horizontal.

"The remainder of the arch was built of shale brick masonry laid in 1:2½ Portland cement mortar. The bricks were ranged in Flemish bond. In the tunnel the brick work was carried out to a full bearing against all roof timbers. The spaces between the timber sets were packed with earth. The spaces between the vertical side posts were built in solid with brick masonry.

"The centering consisted of three layers of 2 by 12 in. planks bolted together, forming ribs 6 in. thick, without any radial or cross bracing. The outer layers of planking were one-fifth of a semi-circle in length and the middle thickness one-third of a semi-circle. The ribs were bolted together in three sections, and were thus easily taken down and re-erected. From 20 to 40 ft. of centering was set up at a time, with ribs spaced about 3 ft. apart, so as to clear the tunnel timbering.

"After the brick work of the arch was built up to the inner roof timbers of the side tunnels screw jacks were set upon the arch ribs just above the inner rafters of the side tunnels. They were then turned up until the inner rafter was loosened and removed, when the brick work was continued, giving full support to the inclined roof timber of the central tunnel as it progressed. As soon as the brick work passed the joint between the two inclined roof timbers the jack was removed and the entire weight of the tunnel roof was transferred to them.

"The arch was keyed by the use of jack-lagging in the ordinary manner. As the vertical props in the roof tunnel were encountered they were sawed in two and removed.

"The excavation of the core was begun on April 20th and finished on May 9, 1901. An elevator for mine cars was erected in the shaft at the east end and the earth was removed by those cars and a tram track on the floor of the excavation. The cross braces of the side tunnels were left built solidly into the concrete of the side, and their ends protrude through the side walls. On account of soft foundations the excavation for the entire tunnel work was carried from 1 to 3 ft. deeper than would otherwise have been necessary.

"The concrete for the foundation under the invert was put in place by building a tram track upon timbers laid across the sewer at about the level of the lower tier of cross timbers as shown in Fig. 5. The concrete was brought down in cars and dumped into the bottom from this track. The work was carried on from the farther end of the tunnel, working backward toward the shaft. The protruding timbers were then cut off far enough back to permit the brick lining of the tunnel to be laid. After all the masonry had been completed in the tunnel the portion of the sewer in open cut at the east end was built up, thus completing the tunnel.

"The entire tunneling operations were carried on under the direction of the engineer in charge by a force of tunnel men who had had much experience in other tunnels in Cleveland and elsewhere."

The wages paid the men on this tunnel work was as follows:

	Cents Per. Hour.
Engineers	25
Firemen	12½
Track watchers	13½
Concrete men	22½
Concrete men	17½
Concrete men	30
Concrete men	15
Signal boy	12½
Watchman	12½
Superintendent	50
Tunnel foreman	40
Tunnelmen	35
Tunnel helpers	25
Tunnel helpers	20
Carpenter	25
Carpenter's helper	17½
Mason	50
Mason	60
Mason's helper	17½
Mortar mixer	17½
Brick helper	15
Laborers	15
Team	35
Foreman	30

The following are the quantities of work that were done:

	Feet.
Lenth of tunnel	144
Length of sewer in open cut	46
Total	190

EXCAVATION:

	Cubic Yds.
North drift	864.00
Top drift	517.87
South drift	842.67
Core drift	499.84
Open cut, west end	572.97
Open cut, east end	187.72
Total excavation	3,485.07

CONCRETE:

	Cubic Yds.
North drift	349.12
South drift	364.75
Bottom drift (core)	103.84
Open cut, west end	199.11
Open cut, east end	79.28
Total concrete	1,096.10

SHALE BRICK MASONRY:

	Cubic Yds.
In tunnel	618.24
Open cut, west end	113.97
Open cut, east end	46.43
Total brick masonry	778.64

The total cost of materials and labor was:

Brick	$3,375.45
Cement	2,187.30
Sand	604.00
Stone	1,136.45
Coal	651.30
Lumber	4,354.30
Labor, brick masonry	2,011.47
Labor, concrete	1,207.91
Labor, tunnel and eng.	9,943.07
Labor, common	7,060.11
Labor, foremen	324.55
Labor, superintendent	2,232.55
Miscellaneous	2,636.72
Total cost	$37,824.93

The unit cost of excavation and the setting of timber, which was kept as one item, was as follows:

	Per Cu. Yd.
Side drifts	$5.72
Center drift	6.01
Core	1.25

The last item includes the cost of removing centering for the arch, this centering being supported by the core left in, and was taken out as the excavation was made. These unit costs also include foreman, superintendence and other items of cost. The yardage, per lineal foot of tunnel, of excavation was 18.9, which gives an average cost per cubic yard of $4.96, and a cost per lineal foot of tunnel of $93.74.

The cost of excavation in west open cut per cubic yard was $1.84. This high cost was due to the fact that the material was wet, sticky clay, very hard to handle, and as it was excavated by hand, being cast on to scaffolds and thus thrown from the trench, it required from six to eight men to do the work.

The unit cost of excavating the east open cut was $5.20 per cubic yard. This is not a fair price for the excavation work, as this cost includes the grading of a roadway to the work, setting up the engine and drift, and all other expenses of getting started, during August and the early part of September, when the work was commenced. More than half of this charge was for the tunnelmen who had to be put at this work and for the superintendent. Track watchers are also included in this cost.

The labor cost of mixing and placing concrete was $1.36 per cubic yard. The cost per cubic yard for building the brick arches was $5.46. This does not include the brick lining in the bottom of the culverts. This cost does include the bringing of the materials into the tunnel, the storing of them during cold weather and the rehandling when the masonry was built.

There were 97.37 cubic yards of brick masonry in the invert of the bottom of the culvert, and 52.67 cubic yards of brick masonry in the arch of the east end open cut. This with some extra concrete work in the bottom, the finishing of all the masonry work, and the maintaining of a watchman at the end of the work, until the plant could be moved away, and cleaning up of the work, cost $1,905.50 for labor. These items were not kept separate but were grouped together.

The taking down of the bulkhead in the sewer and the building of test arches cost the lump sum of $464 for labor. In keeping account of materials a separate record was not kept of each detail for which materials were used, so we have grouped them as above. The labor costs of the excavation and concrete were kept carefully and are as given.

Cost of Digging Holes and Planting Trees and Shrubs.

In carrying on many earthwork jobs, the engineer not only has to think and plan for the engineering features of the work, but he also has to consider and keep in view the artistic side, namely, the landscape features. This is rapidly becoming the case with railroad work, as the right of way of some of our larger roads is being terraced, hedges planted, and banks sodded or seeded, and the station grounds made into smooth lawns with shrubs and trees to ornament them, and well kept drives laid out through the grounds. Sewerage disposal plants, reservoirs and filter beds are likewise treated in this manner. This has made landscape architecture or engineering more prominent, and the civil engineer finds that he must give attention to these matters. If he has much of this work to do he will call in an expert on the subject, but if the work does not warrant this expense, he will attend to the details himself.

In this class of work, the planting of trees and shrubs is quite an important item. Nothing adds so much to a landscape view as trees and shrubbery, yet in making excavations these are the first things to go. The land must be cleared and grubbed before the excavation is made.* When the work is finished, trees and shrubs must be planted again. The cost of the trees needed, can be obtained from any nursery company, but the cost of planting is more difficult to obtain.

One of the editors of this journal has done this work upon several occasions, and the following costs were kept several years ago.

The trees in the first example were known as 4 to 6 in. trees, that is, trees measuring from 4 to 6 in. in diameter. They were maples and poplars, and were bought in the early spring and "healed" in, on a nearby lot to be planted later.

Example I. In this lot there were 80 trees. The ground had been graded, to a depth of 1 to 5 feet, hence there was no soil left. For this reason it was necessary to dig a deep hole and fill it in with good soil so as to give the tree every chance of growing. The spread of the roots was about 2½ ft. on the trees, hence a hole 5 ft. in diameter and 5 ft. deep was dug. Two men working together dug the holes, digging four such holes in a day. A pick and short handled shovel were used by them. The dirt was thrown on the side of the hole, wheel scrapers moving it away, but this cost was not charged against the tree planting as it saved borrowing that much earth elsewhere, hence this was charged against the borrow that was being made to fill in an adjoining marsh. In each hole there was 3.6 cu. yds. of earth. The wages paid for a nine-hour day were as follows:

Foreman	$3.50
Men	1.50
4-horse team and driver	7.50
1-horse cart and driver	3.50

About six men worked in the gang, and the cost of digging the 80 holes was:

Foreman, 6½ days	$22.75
Men, 40 days	60.00
Total	$82.75

The cost per hole was:

Foreman	$0.28
Men	0.75
Total	$1.03

This gave a cost per cubic yard of earth excavated as follows:

Foreman	$0.08
Men	0.21
Total cost per cubic yard	$0.29

It must be remembered that this kind of excavation is very similar to trench work, and also to shaft sinking, as the picking is always from the top of the excavation, and in shoveling, the shovel cannot be heaped as easily as when working against a breast.

In planting these trees soil had to be hauled several hundred feet from nearby stock piles. Woods earth was also hauled from a piece of woodland a half a mile away. Twenty-five cents a yard was paid for the privilege of getting it, and the cost of hauling and loading it is included in the cost of the tree planting. A four-horse dump wagon that carried 2 cu. yds. each trip was used for this. This wagon also hauled some loads of "mulch" from the seashore close by, a haul not exceeding 700 ft. A cart was used to haul soil and water

The method of planting the trees consisted in filling in the bottom of the hole for about 2 ft. with soil, then using a mixture of soil and woods earth, in the same manner in it, to fill up the hole within a few inches of the top. The roots of the tree were covered with about 10 in. of this mixture of soil. The last few inches was of the "mulch" from the seashore, as this kept the ground moist and prevented it from baking. As the tree was planted, plenty of water was poured around it. The placing of rich soil around the roots and the watering allowed the fibrous roots to begin at once to take nourishment for the tree. The planting was done in the summer time, thus making it necessary to take unusual precaution that the tree should grow. After the trees were planted they were watered and sprayed each day that it did not rain.

---

*For Costs of Clearing and Grubbing see Engineering-Contracting, Oct. 17, 1906, page 98; Feb. 27, 1907, page 93; Dec. 25, 1907, page 355.

The cost of the tree planting for these 80 trees was as follows:

Foreman, 3 1-2 days	$12.25
Men, 20 2-3 days	31.00
Team, 4 days	30.00
Cart, 4 days	14.00
Wood's earth, 12 cu. yds. at 25c	3.00
Total	$90.25

This gives a cost per tree of the following:

Foreman	$0.15
Men	0.39
Team	0.37
Cart	0.18
Woods earth	0.04
Total	$1.13

This makes a total cost per tree, of digging the holes and planting, of $2.16.

Example II. In this case 270 trees of about the same size were planted. The work was done in the fall of year, after the sap ran down, and the ground in which they were planted had several feet of fairly good soil on it. The tree holes were made for this reason 5 ft. in diameter, but only 4 ft. deep. This meant the excavation of 2.9 cu. yds. for each hole. The wages paid for a 9-hour day were the same as in Example I, but instead of working only about six men in the gang, about 24 men were worked. It will be noticed that this materially reduced the foreman cost. The cost of digging the 270 holes was:

Foreman, 4 days	$ 14.00
Men, 95 days	142.50
Total	$156.50

The cost per hole was as follows:

Foreman	$0.05
Men	0.53
Total for hole	$0.58

The cost per cubic yard of earth excavated from the holes was:

Foreman	$0.02
Men	0.18
Total cost per cubic yard	$0.20

A comparison of this with the cost of digging the holes for the 80 trees will prove interesting. The unit cost of the foreman was reduced as explained by increasing the size of the crew of laborers, but it will be noticed that cutting off a foot of the depth (25 per cent) of the hole, decreased the cost of digging about 30 per cent. The cost of excavating per cubic yard was decreased 14 per cent. Two men working together nearly completed six 4-ft. holes in a day.

In planting the trees the same earth and soil that was dug from the hole was put back, hence the cost of planting includes the labor of back filling, the getting of the tree from the "healing in ground," the placing of it, putting some little manure around the tree after it was planted and watering while planting. No teams were necessary for this, the cost being as follows:

Foreman, 1½ days	$ 5.25
Men, 36 days	54.00
Total	$59.25

The cost per tree was:

Foreman	$0.02
Men	0.20
Total	$0.22

This makes a total cost of planting each tree of 80 cts., and illustrates how much cheaper the work can be done when the season is favorable, and the soil does not have to be hauled and prepared to place around the trees.

Example III. In this case 60 evergreen trees of various kinds from 3 ft. to 12 ft. high were planted. Earth was taken up with the roots, at the nursery where they were bought, and burlap was tied around the roots to keep this earth from falling off. As these trees were unloaded from the car, they were carried by the men directly to the place they were to be planted. Teams could not be used for this as the lawns, new ones, would have been ruined by the passage of wheels over them. From 2 to 4 men were needed with hand sticks to carry each tree. The holes dug were about 2½ ft. in diameter and about 18 in. deep, there being about 6.4 cu. ft. of earth excavated from each hole. The back filling was done from this material, it being soil; the material being piled up around the tree, leaving but little excess to be hauled away in wheelbarrows. Large pieces of canavs were laid down on the grass to hold the excavated earth, thus preventing the earth from injuring the grass. The entire lot of trees was planted in one day, and the cost consists of unloading the trees from the cars, carrying them to place, digging holes, planting trees, and cleaning up the ground and pieces of canvas afterwards. The ground was wet enough from recent rains to do away with watering the newly planted trees. The entire cost of this work was:

2 Foremen, at $3.50	$ 7.00
33 Men, at $1.50	49.50
Total	$56.50

The cost per tree was as follows:

Foreman	$0.115
Men	0.825
Total	$0.940

Example IV. This job consisted of planting 1,200 shrubs. About one-third of them were planted as separate shrubs or three or four plants in the same hole, the rest being planted as hedges. The holes were dug about 1 ft. deep. A foreman and 3 men did the work, taking the shrubs from the "healing in ground," digging the holes, planting, back filling and watering. The wages were the same as paid in the other examples. The cost was as follows:

Foreman, 5 days	$17.50
Men, 15 days	22.50
Total	$40.00

This was a cost of 3 1-3 cents per shrub. All the work was done by day labor.

Method of Drilling and Mucking in a Rock Tunnel and a Comparison in the Tunneling on the Rand.

In the May, 1907, issue of the Mine and Quarry, Mr. W. P. J. Dinsmoor, of 1748 Broadway, Denver, Colo., has an article on rock tunnel work in connection with a western mine. We abstract the following:

The Ophelia Tunnel in the Cripple Creek District of Colorado was driven for the purpose of draining mines, and transporting ore and waste from deep levels of such properties as it might cut.

This tunnel has been driven to a point approximately 8,500 ft. in a direct line from its portal. It is for its entire length 9 ft. by 9 ft. in the clear, and in places will show 10 ft. by 12 ft.

The tunnel was driven through granite, then into breccia, with intervening dykes of phonolite, andesite, and nephaline basalt, at an average rate of 350 to 375 ft. per month. 350 ft. per month was considered low, and such a result called for investigation by the management of the causes which reduced the work accomplished to this figure. The record month showed an advance of 395 ft. and 8 ins. This speed in driving was obtained by careful planning of the work, so there would be no loss of time or idleness for either the men or equipment. This required a thorough study of the conditions that were to be met and overcome, and careful oversight to see that the plans adopted were carried out. The plant used on this work consisted of two 60- H. P. boilers; one straight-line, two-stage air compressor; one high-pressure, three-stage, locomotive-charging compressor; one compressed-air locomotive and Sullivan "Class UE-2," 3-1-8 in. drills.

The working day was divided into three shifts of eight hours each.

Plan of Work.—In the actual tunnel-driving work, there were seven men to a shift: two machine drillmen, two machine helpers and three "muckers." Each shift was supposed to drill, load and shoot a round of from 18 to 22 holes, drilled from 5½ to 7 ft. in depth, as well as to load the "muck" resulting from the work of the previous shift into the cars, and deliver the cars to the compressed-air haulage engine. The management feels that under the three-shift plan the men do better work and take more pride in its results, owing to the fact that the men know that another shift is following close on their heels to perform the same operations that they have performed, and that the following shift depends upon the satisfactory completion of this shift's work for the accomplishment of their own.

The method pursued was essentially as follows:

As soon as the smoke resulting from the shooting done by the previous shift was cleared, the new shift of drillmen, helpers and "muckers" all went to work, and the broken rock from the face was thrown back sufficiently to allow the columns for mounting the drills to be put in place. The two drillmen worked together, and the two helpers worked together in pairs, relieving each other at intervals; the "muckers" going immediately to work, getting the "muck" into the cars and on its way to the dump. When the helpers were working on the muck pile, the drillmen were back of the work; looking up equipment; seeing that all the machine drills, steel, hose, tools, blocking, etc., that would be required for the shift's work were on hand, and, if anything was found missing, taking steps to secure it. When the drillmen were working on the muck pile, the helpers were employed in bringing the required material up to the face, where it would be readily available.

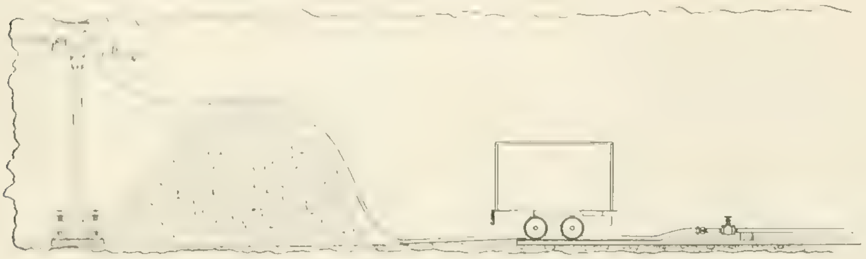


Fig. 1—Sketch Showing Arrangement of Drills.

It may be objected that this would be possible only in a short tunnel, but in this tunnel, about 1 2-3 miles long, this work was accomplished by each shift every day. As soon as the muck was cleared away from the face, the columns were put in place; the drills mounted, and the drilling of the new round commenced.

In clearing away the muck, care was taken that it should not fall back toward the face until a sufficient space was provided in which to set the columns. After the columns were set, the muck was allowed, and in fact encouraged to fall back, until it had filled the space in front of the face up to such a level that the tops of the jack screws of the columns could just be reached. By this method, the back holes, or those nearest the top of the tunnel, were the first to be drilled, and the drillmen and helpers worked from the top of the muck pile. This did away with any form of staging, and while the drillmen worked towards the bottom of the tunnel, the muckers were removing the pile, thus always giving the drillmen a standing ground of proper height, or really a self-adjusting platform, much wider and more solid than any portable timber staging. It was of course necessary for the muckers to finish loading out the muck before the drillmen reached the bottom holes or "lifters," but they did not stop work until the end of the shift was reached, as there was rail laying, and the placing of sheets, to occupy their attention until the holes were loaded and ready for shooting. Everyone on the shift was busy from the time he reached the heading until the holes were loaded and fuses spit. The only time lost in the 24 hours of the day was that required for changing shifts and the clearing of powder smoke.

Full length mining columns were used, in order to reduce the amount of blocking needed at the top and bottom of the columns, and to insure the removal of the muck from the face, clear to the bottom of the tunnel before the set-up, so that resetting would not be required when the bottom holes were reached.

Care was always taken to see that the men were well supplied with all material for their work. Empty cars were always kept at the face; an extra machine drill was constantly on hand, so that if one of the drills in use required repairs, it could be laid aside, to be put in order by a skilled mechanic. Thus the drillman and his helper were not delayed by making repairs. Plenty of sharp drill steel and water for use in the holes were kept close to the face.

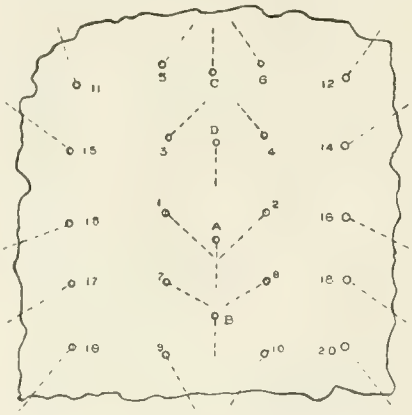


Fig. 2—Arrangement of Drill Holes.

Arrangement of Drill Holes.—The important matter of properly placing and shooting drill holes was carried on as follows: In Fig. 2, holes Nos. 1 and 2 are cut holes. These were drilled from 6 to 7 ft. deep, looking down, and were so placed and directed that their inner ends nearly met. The fuse for these holes was so cut that they were fired first and nearly at the same moment. Holes Nos. 3 and 4 are cut holes, drilled looking up and about the same depth as Nos. 1 and 2. They were so directed that their inner ends did not meet, as in the case of Nos. 1 and 2. The fuse was so adjusted that these holes were fired just after Nos. 1 and 2. Holes Nos. 5 and 6 are the back cut holes. They were drilled looking up, and so directed that their inner ends did not meet, nor did they extend beyond the top of the tunnel. These holes were shot together and just after Nos. 3 and 4. Cut holes Nos. 7 and 8 look down, and were timed to shoot after Nos. 5 and 6. Holes Nos. 9 and 10, the cut lifters, look down and extend below the proposed bottom of the tunnel. Holes Nos. 11 and 12, the back rib holes, and holes Nos. 13 and 14, rib holes, look up. Holes Nos. 15 and 16, also Nos. 17 and 18, rib holes, and holes Nos. 19 and 20, rib lifters, all look down and all extend beyond the line of the side walls, and were all shot at nearly the same time.

Where stiff ground was encountered holes A and B were put in, and shot with holes Nos. 1 and 2 and Nos. 7 and 8 respectively. Where very stiff ground was found, holes C and D were added and shot with holes Nos. 5 and 6 and Nos. 3 and 4 respectively. By analyzing the above it will be found that holes Nos. 1 and 2 take out or loosen a wedge-shaped portion of the rock, thus relieving the resistance to the action of the powder in holes Nos. 3 and 4 and holes Nos. 7 and 8. Holes Nos. 3 and 4 and Nos. 7 and 8 clear the way for holes Nos. 5 and 6 and Nos. 9 and 10. Holes Nos. 9 and 10 have a tendency to throw any broken rock above them out of the way of the remaining rib holes. Holes A, B, C and D serve simply to increase the effect of the holes with which they are shot. By placing the holes in this way and shooting in this order, the break, with very few exceptions, always cleared the rock for the full width and depth of the tunnel, thus doing away with the necessity of following the heading with any work designed to break off projections.

Tamping material for use in the loading of the holes was always employed. It was found that by using this, the results obtained were most satisfactory, and that less powder was consumed.

Handling the Muck.—Two tracks were maintained close to the heading. Before the shots were fired, steel sheets were placed on the floor close to the face, extending back far enough to receive all the broken rock. It was found important to have these sheets weighted, and enough muck was kept at the face to do this properly. The sheets formed a smooth floor from which to shovel the muck, but unless the sheets were weighted, it was found that the vacuum created by heavy shots was likely to lift them and mix them with the muck, thus not only defeating the purpose for which they were intended, but actually increasing the labor of mucking. The sheets behind the main portion of the muck pile served to receive part of the muck thrown from the face, and also to facilitate the handling of cars.

A convenience for saving time was the use of a flanged valve on the heading end of the pipe line, instead of the screw valve commonly employed. There was also a telephone system, one station of which was kept well up toward the heading. In case of accident, or when it was necessary to communicate with the portal or power house, the use of the telephone saved valuable time.

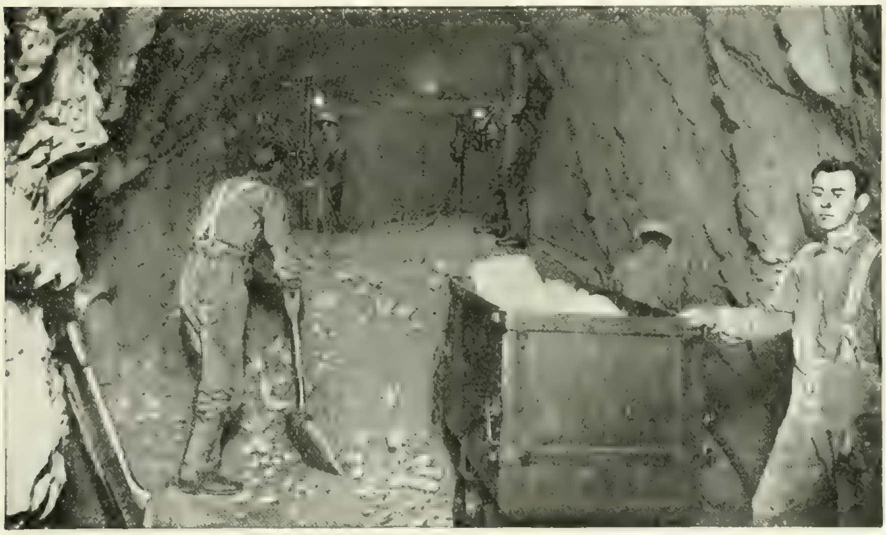


Fig. 3—Showing Tunnel Work in Progress.

Ventilation.—The removal of powder smoke after shooting was accomplished by means of a blower and the compressed air system. As soon as the work of drilling stopped, the engineer would notice the fact that the demand for compressed air had ceased; he would then fill the receivers and pipe lines with air at 100 lbs. pressure. After the holes were loaded and fuses spit, the drillmen would open the gate valve at the heading, allowing a full stream of air under 100 lbs. pressure to play on the face through a 1-in. whistle cock. This volume of air, coming with a high velocity, stirred up the smoke and mixed thoroughly with it. The pressure in the pipe lines dropped rapidly, and as soon as the pressure reached 20 lbs. the engineer started the compressor and kept the pressure at this point, and also started the blower, if it was not already running. A 15-in. ventilating pipe was used and the smoke was soon thoroughly mixed with fresh air. It was seldom that men could not get to the face 20 mins. after the shots were fired.

In the Engineering and Mining Journal of October 26, 1907, Mr. Dinsmoor makes a comparison of this work with that done in the Cinderella mine, in Transvaal, account of which appeared in Engineering-Contracting Nov. 20, 1907, page 291. Mr. Dinsmoor has the following to say:

Taking the figures from these two articles we have the following comparative table:

	Rand.	Cripple Ck.
Size of bore	5x7 ft.	9x9 ft.
Rate of progress per mo.	225 ft.	375 ft.
Number of machines used per shift	3	2
Number of men employed per shift	8	6
Number of holes drilled per round	15	20
Length of shift, hours	8	8
Max. distance over which spoil had to be trammed	800	8,500

From the above figures we can strike averages and derive the following:

	Rand.	Cripple Creek.
Lineal ft. advance per shift	2.43	4.03
Cu. ft. rock broken per shift	85.05	320.43
Percentage of advance, lin. feet	60%	...
Percentage of advance, cu. feet	26%	...
Percentage of machines used	150%	...
Percentage of men used	133%	.....
Percentage of holes drilled per round	75%	.....

The work on the Rand was carried on with a greater number of men and machines. The Rand tunnel was driven to single track size to be later widened to accommodate double tracks. Not so with the Cripple Creek tunnel, which was at all times kept up to its required width.

That there must be causes for the difference in speed as shown above, is self evident. These causes must rest upon four things, viz., the hardness of the rock; the method employed in doing the work; the efficiency of the men; and the efficiency of the machinery.

The rock encountered in the Rand tunnel was undoubtedly harder on the average that that in the Cripple Creek tunnel, though some of the rock at Cripple Creek was probably as hard. The cylinder diameter of the drills used in the Rand tunnel was 3¼ in. and that of the Cripple Creek drills was 3⅛ in. The drills in the Rand tunnel put in on an average five holes each per shift, while those in the Cripple Creek tunnel averaged 10 holes each per shift. In view of these facts it would hardly seem that the rock, even if much harder on the Rand, could be held entirely responsible for the difference in the speed accomplished.

It may be that the Rand tunnel was being widened at the same time that the heading was being advanced, in which case it is possible that the tracks over which the spoil from the heading was being trammed were more or less blocked by the drills and the broken rock at the point where widening was in process. This blocking, if extensive enough, might well be the cause of delays in getting the spoil away from the heading and thus delay the work of advancing the heading. From the data that we have at hand, this would not seem to be the case, and it would appear that a round of holes was drilled and shot each shift. Therefore, it would not be right to charge delays to this until further confirming information be secured.

The fact that the Rand tunnel was driven smaller than the Cripple Creek tunnel may also account for some delay. While it would naturally seem that a small tunnel could be driven faster than a large one, at the same time this has not always been the case. The larger tunnel in some cases can be driven faster than the smaller tunnel owing to the fact that the rock breaks more easily. The powder having a larger face to work on, consequently breaks deeper per round, and the larger tunnel also gives more room in which the drillmen and shovelers may work, so that a round of holes is drilled fully as quickly in the larger tunnel, or even more quickly, and the additional size gives the shovelers the additional room necessary to get out a larger amount of rock.

The difference in the speed of drilling can hardly be charged up to the hardness of the rock. Therefore, it would seem that it must be charged either to the method employed, i. e., that of driving a small tunnel instead of a larger tunnel, or to efficiency of men or machines employed.

In reading the two articles, one is at once struck by the fact that it is likely that nearly the same methods have been followed in driving these two tunnels, as to ventilation, time saving, etc., and that the principal difference in methods were in the manner of using the rock drills and in the breaking the full tunnel either in one or two operations.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Methods and Cost of Transmission Line Construction for Interurban Electric Railways.*

By F. F. Roberts and J. C. Gillette.

II.

The catenary supported trolley has been developed during the last two or three years. This method of suspension provides a safe means of supporting the trolley wire with spans up to 300 ft. in length. In this class of construction the trolley wire is suspended from a steel messenger wire supported by insulators carried on brackets, cross suspension cables or bridges. The trolley is supported from the messenger wire by hangers spaced from 10 to 50 ft. apart, depending upon the design. The physical limit of span in this class of construction is determined by the strength of the messenger cable, and also to a slight extent by the lateral movement of the trolley caused by wind pressure. It is evident that the tighter the messenger wire, the less will be the lateral movement in the trolley, but as the stresses in the messenger on spans of the same length and loading increase approximately inversely as the sag, care must be taken not to run above the safe loading of the messenger, especially under conditions of sleet and high wind.

There are two general classes of catenary construction, the single catenary, and the double catenary. In the single catenary construction the trolley wire is supported from a single steel cable carried by insulators upon the brackets or spans, while in the double catenary the trolley wire is carried by two steel cables.

In either type of construction the messenger cables may be carried either by brackets, span wires, or bridges. In ordinary interurban trolley construction, we usually find the messenger carried by a bracket, while in city streets we frequently find span wire construction. The bridge construction consisting of towers on each side of the track and a bridge spanning the tracks is seldom used for anything but the heaviest class of work, such as electrified steam railroads.

The bracket construction is the cheapest in nearly all cases, and is usually satisfactory for the purposes of the ordinary interurban road. The span wire construction is only used where conditions are such as to require it, as the span construction is rather expensive and not particularly satisfactory. It requires longer poles and produces a more severe loading of the poles than is the case with the bracket construction.

The double catenary construction produces a structure which is very rigid as regards wind pressure and yet is flexible as regards vertical pressures. This type is the highest development of the art at this time, but because of its great cost is only used in the electrification of trunk lines of the heaviest class. It is not proposed in this article to discuss this phase of electric railroading, but to confine it to simpler and less expensive forms that are applicable to ordinary interurban roads.

As ordinarily constructed the single catenary trolley has a pole spacing of from 100 to 150 ft. and the trolley is attached to the messenger cable either by means of three hangers placed at intervals of 40 to 50 ft., or by means of nine or more hangers placed at intervals of 10 to 17 ft. The spacing referred to is, of course, the normal spacing and a larger or smaller number of hangers with longer or shorter spacing is used where local conditions require.

For convenience, we will hereinafter refer to the three hanger type of construction as the long spaced type, and that using nine or more suspension hangers as the short spaced type.

Messenger Cable.—In the single catenary construction the messenger or cable which supports the trolley consists of a steel cable ranging from perhaps 5-16 in., as a minimum, to ½ in. as a maximum, diameter, and usually made up of a seven wire strand, either of the grade known as "Siemens-Martin" steel or that designated "high strength steel." The cable is supported by porcelain insulators, such insulators being usually mounted on iron brackets. The following table gives the ultimate strength of the ordinary sizes of steel strand of the various grades:

Diam. Ins.	Reg.	Siemens-Martin	High Strength	Extra H. S.
¼	.	3,050	5,100	7,000
9-32	.	4,380	7,300	10,900
5-16	..	4,860	8,100	12,100
⅜	5,700	6,800	11,000	17,250
7-16	7,500	9,000	15,000	22,500
½	9,800	11,000	18,000	27,000
⅝	...	19,000	25,000	42,000

The prices of cable bear such relation to the strength that the cost of cable necessary to carry the given load is approximately independent of the grade of cable used. However, the lower grades of cable suffer most from corrosion, while the better grades are hardest to manipulate. It is practically impossible to "splice" the high strength or extra high strength steel cable, and all joints in such cables are made by means of clamps.

Brackets.—As there is considerable difficulty in keeping insulators in an upright position on pipe brackets, brackets are now generally made of 2¼x2¼x¼ or 5-16 in. T bar, or 2x2¼x¼in. angle bars supported by a rod or strut. The insulators are attached to a suitable pin casting by means of Portland cement, such pin casting being held to the brackets by set screws.

Insulators.—The insulator is the vital point in high voltage trolley line construction, and as this insulator is subject to severe service, care should be taken in its selection. Insulators for 600 voltage work are generally 3x3½ ins., one piece, double petticoat porcelain insulators, and tested for 5,000 volts. Of course with higher voltages, larger insulators are used; for example, with 6,600 volt current, insulators as large as 8 ins. in diameter by 5 ins high are in use.

Hangers.—The hangers used to support the trolley from the messenger, in general consist of a mechanical clamp for the trolley, usually consisting of two sections drawn together by screws and resembling the so-called "Detroit" type of ear used in direct current practice. The attachment to the messenger is made by means of a clamp or metal loop, bolted around the messenger, or by means of a pair of sister hooks which are slipped over the messenger and driven down so as to tightly grip the wire. The connection between these two clamping ends is made by means of a round or a flat bar, or a pipe, attached to the above-mentioned parts by means of rivets, screws, or pipe threads

All bolts and screws used in hanger construction should be thoroughly locked, as otherwise the vibration is certain to result in their working loose. The hanger should preferably expose as small an area as possible to wind at right angles to the trolley

Catenary Construction on Curves.—On straight line construction and curve construction up to 5°, it is possible to maintain the 150 ft. pole spacing, but at 4° and 5° it is advisable to install a brail guy with two pull-offs per span. In installing pull-offs for catenary work, especially if pantograph trolley is to be used, great care must be taken to see that proper clearances are given for the end of the pantograph trolley, which on curve work will rise higher than the trolley wire itself, owing to the super-elevation of the rail at this point. The pull-off hangers, as they are called, for curve work are similar to the regular hangers except that they have an eye placed about 2 ins. above the trolley wire and another one about 2 ins. below the messenger. A short bridle is attached to these eyes and a strain insulator is cut in on the pull-off wire.

On curves up to 3° the curves are held to position by means of steady braces, the brace being an insulated stiff rod attached to each bracket or pole and to the trolley wire in such manner as will resist any movement in a horizontal direction. There are several types in use at present. The earlier type consisted of a treated hickory rod attached to the pole by means of suitable clamps, and to the trolley wire by means of an ear similar to the regular hanger ear; this ear in turn being fastened to the rod by a gooseneck by means of a long threaded section for adjusting the position of the trolley wire. The more recent types are attached to the bracket arm, and do not depend upon the wooden rod for insulation but on porcelain insulators of the skirt type, similar in general construction to those supporting the messenger wire. There are two types in use, one having a long arm, which is attached to the bracket close to the pole, and the other having a short arm, which is attached to the outer extremity of the bracket; the arms in both cases being so hinged as to allow vertical but not horizontal motion.

---

*Abstracted from [illegible] Traction Weekly by special [illegible] of the publishers.

It is advisable to install half anchorages at each end of curves of over 2° in order to take care of the strains resulting from contraction in the line each side of the curve.

There is practically no tendency for the trolley to move sidewise, due to the passage of the trolley wheel or pantograph, as the messenger acts in effect like a large spring, and as soon as the trolley wheel or pantograph relieves it of some of the tension due to the weight of the trolley, the messenger will rise and thus keep directly over the trolley wire.

Sidings.—On siding construction, if the wheel trolley is used, the construction is similar to that used on high speed d. c. interurban roads; that is, the siding trolley is brought out to the main line at the switch, and then carried down the main line, parallel to and about 12 ins. distant from the main line trolley for a distance of 150 or 200 ft.

If the pantograph trolley is used, the deflector set, as it is called, consists of a number of trolley wires or steel rods of similar cross section. These are held to place by ordinary trolley ears, which in turn are bolted to cross bars spaced about 3 ft. apart, these cross bars being supported by the main line and siding trolley wires. The ends of these rods are raised 4 or 5 ins. above the siding and main line trolley so that there is no possible chance for the end of the pantographs to catch them. The siding trolley wire is passed over the top of the main line trolley wire and carried to an anchorage on the farther side. A deflector set should be installed on both sides of the main line trolley to avoid any danger of the pantograph catching trolley or guy wires. Care must be taken in this construction to see that the siding trolley is pulled up so that the raising of the main line trolley, owing to the passage of trolley wheel or pantograph, raises the siding trolley as well. It must also be designed so that the effects of lateral travel in the main line trolley, due to expansion and contraction, will not affect the height of the siding trolley.

A number of different types of section insulators are in use for this class of work. It is now recognized that the early forms, which depended on long breaks for insulation, are not practical. While at first they give fairly satisfactory results, climatic conditions soon produce leakage and make it unsafe to work on a section protected by such insulators. There are two or three different types of section insulators which have either a long air break or a series of short air breaks in their construction, and these give promise of proving satisfactory.

Overhead Crossings.—Probably the points which have given the most trouble to designers of catenary supported trolley work are those points on the line where the line is crossed by overhead bridges, used to eliminate grade crossings, as every foot these bridges are raised means an increased cost for the approaches and the structure, and the same is true if the clearance height between the bridge and track is increased by lowering the track grade. Consequently at these points the trolley is usually depressed to the lowest possible working limits.

Both the tension of the trolley and messenger and the upward pressure of the collecting device tend to lift these wires into contact with the bridge structure and they must be so secured as to resist these forces. In the case of ordinary d. c. construction, the trolley is rigidly supported by hangers closely spaced under the bridge, and the d. c. type of hanger is well adapted to resist such upward pressure. But with catenary construction the trolley and messenger must be flexibly supported and held securely against lateral and vertical motion, and this must be done in extremely limited space, and at the same time maintain clearances suitable for the voltages used. Catenary trolley construction requires approximately 18 ins. more clearance, or head room under bridge crossings than the ordinary d. c. trolley; this, of course, is based on trolley voltages of from 3,300 to 6,600 volts, where an air space of at least 5 ins. must be maintained between the messenger and trolley and the adjoining frame work of the bridge.

Two general types of bridge construction are in use, one known as the sleeve type and the other as the skirt type. The sleeve type consists essentially of a corrugater porcelain tube of proper length and thickness for the voltage used, which is supported on a bracket attached to the bridge; the messenger is tied to this, and the construction in other ways is similar to the ordinary bracket construction excepting that at this point a steady brace is installed which is anchored in such a manner as to prevent the trolley rising.

In the skirt type, the construction is similar to the ordinary bracket construction except that the insulator pin, instead of being supported by a bracket arm, is supported by either a wooden or steel bracket bolted to the bridge, and the messenger is suspended from a line insulator as usual in bracket construction. In addition to this, extra hangers are placed between the two bridge supports in order to prevent the trolley wire rising at the center, because of the upward pressure of the pantograph or trolley wheel. On each side of the bridge at a distance of 20 to 25 ft., is placed what is called a "hold down span" consisting of two heavy poles securely anchored, with a cross span drawn tightly between them, the design of the span being such as to limit any rise of the trolley and messenger either because of contraction in the main line, or from lifting action of the trolley wheel.

With either construction the trolley and messenger wires must be protected from bridge drippings by means of a suitable metal shield attached to the bridge structure and thoroughly grounded. At points each side of the bridge where the trolley wire reaches its normal height half anchorages are installed in such manner as to pull slack towards the bridge.

Messenger Tension.—In erecting catenary trolley work care must be taken to see that the messenger wire is so pulled up that there will be exactly the same amount of deflection in spans of the same length. If this deflection is secured for the standard length spans, the shortened spans will take care of themselves, and the strains in all spans, due to loading, etc., will be the same. Unless the deflection is the same in spans of the same length the strains arising from the loading of the trolley and also the vibration which is met in service will cause the messenger wire to "travel." This travel manifests itself by unequal strains on the messenger insulators and unless the tie is made very securely, the messenger wire will slip through and in this manner tend to equalize the tension, but the hangers will no longer stand vertically but will lay at an angle producing an uneven trolley surface, as well as an unsightly appearance of the whole construction. If the messenger wire does not slip through the tie, it will sooner or later twist the bracket around until the tension is equalized.

The strains in the messenger for any length of span and loading can be calculated by means of the following formula, which is expressed in simple arithmetic:

$S\ W$ = horizontal strain on wire at center of span.

S = strain coefficient.

W = weight per foot of span.

$$S = \frac{Y^2}{2X} + \frac{X}{6}$$

In which $Y = \frac{1}{2}$ the span in feet.

X = deflection at center of span in feet.

For example, with 150-ft. span of ⅜ in. messenger, weighing 45 lbs. and a deflection of 1.5 ft. we will have by substituting the values for the symbols:

$$S = \frac{(75)^2}{2 \times 1.5} + \frac{1.5}{6} = \frac{5625}{6} + \frac{1.5}{6} = 1875.25$$

$$W = .3$$

$S\ W = .3 \times 1875.25 = 562.575$ lbs. strain at center of wire.

If this wire be used to support a trolley wire and hangers weighing 105 lbs. making the total weight supported by the messenger 150 lbs. or 1 lb. per foot of span, we will have $S\ W = 1875.25$ lbs.

If the strains, due to sleet on the wire, are to be considered, the weight of the sleet is added to the weight per foot of wire, and such sleet loading is usually taken as a layer of ice ½ in. thick, on all parts of the structure, the weight of ice being figured at .033 lbs. per cubic inch.

In determining the necessary strength of messenger, it is also usual to allow for the loading due to wind pressure, and this is commonly taken on wires or other cylindrical surface as 15 lbs. per square foot of projected area, such area being taken at the increased figure due to ½ in. thickness of ice, and on flat surfaces at 27 lbs. per square foot. In order to obtain the strain on the messenger wire, due to wind pressure, we must calculate the area of the messenger wire, trolley, hangers, etc., which, multiplied by the pressure per square foot gives the strain due to wind.

The strain due to wind pressure does not add directly to that due to weight, but the total strain in the wire is proportional to the diagonal of a right triangle, of which the load due to weight forms one side, and the load due to wind forms the other side.

In deciding on the size of the messenger wire, it is necessary to allow an ample factor of safety under the most severe conditions. The wire selected should be such as to give a factor of safety of not less than three under such conditions.

Care must be taken in the erection of the wire to allow for contraction of the wire in cold weather and the consequent flattening of the catenary which produces additional strains.

As a matter of fact the strains actually produced are usually materially less than those calculated because the entire structure is elastic and gives more or less, especially at the curves.

Costs.—The accompanying tables of cost show the average between limits of different types of catenary construction. Table No. I shows the cost of single-track catenary 9 point suspension, 150-ft. pole spacing, bracket construction, and designed for 6,600 volt work. Table II shows cost of double-tract catenary 9 point suspension, center pole construction, 150-ft. pole spacing for 6,600 volts. Table No. III shows cost of double-track catenary 9 point double-pole bracket construction, 150-ft. spacing for 6,600 volts.

Table I. Cost Per Mile Single-Track 9 Point Catenary 150-ft. Pole Spacing, 6,600 Volt.

	From	To
36 35-ft. poles in place and framed, poles taken at $6.00 to $8.00 delivered	$ 310.00	$ 430.00
36 brackets with fittings, in place	120.00	150.00
5,280 ft. No. 0000 trolley, 3,382 lbs. @ 20c to 26c per lb	676.00	879.00
5,300 ft. ⅜-in. high strength steel messenger cable	110.00	130.00
36 messenger insulators	15.00	30.00
36 spans catenary hangers	40.00	72.00
5 anchors	8.50	15.00
200 ft. ⅜-in. high strength strand for guys	2.25	2.50
10 steady braces for curves	30.00	40.00
10 strain insulators.....	11.00	15.00
Per cent on material for handling, etc	100.00	130.00
Labor erecting catenary trolley	160.00	200.00
Labor erecting curve trolley 1,500 ft. additional	50.00	75.00
2 half anchorages	20.00	30.00
Siding construction—pro rated	100.00	150.00
Lags, clamps, etc.	10.00	15.00
	$1,762.75	$2,363.50
Add for lightning arresters	10.00	60.00
Add for gd. wire ltg. protection	150.00	200.00
Add for telephone system—pro rated	100.00	150.00
	$2,022.75	$2,773.50
If all poles are anchored add	108.00	180.00
If brackets are insulated	40.00	60.00
Total	$2,170.75	$3,013.50

Table II. Cost Per Mile of Double-Track 9 Point Catenary, Center Pole, 150-ft. Pole Spacing, 6,600 Volt.

	From	To
36 35-ft. poles in place and framed, poles delivered on cars $6.00 to $8.00 each	$ 310.00	$ 430.00
72 brackets with fittings in place	240.00	300.00
10,560 ft. trolley, 6,764 lbs., @ 20c to 26c per lb.	1,352.00	1,758.00
10,600 ft. ⅜-in. high strength steel messenger cable	220.00	260.00
72 messenger insulators	30.00	60.00
72 spans catenary hangers	80.00	144.00
10 anchors	17.00	30.00
300 ft. ⅜-in. strand for guy	3.50	4.00
20 steady braces for curves	60.00	80.00
20 strain insulators....	22.00	30.00
10 30-ft. pull-off poles in place and framed..	100.00	130.00
Per cent for handling material, etc.	110.00	140.00
Labor erecting catenary trolley	320.00	400.00
Labor erecting curve trolley, 3,000 ft. add..	100.00	150.00
2 half anchorages......	40.00	60.00
Siding construction—pro rated	200.00	300.00
Lags, clamps, etc.	10.00	15.00
	$3,214.50	$4,291.00
Add for lightning arresters	10.00	120.00
Add for gd. wire lgt. protection	150.00	400.00
Add for telephone line	100.00	150.00
Total	$3,374.50	$4,961.00

Table III. Cost Per Mile of Double Track 9 Point Catenary, Double Pole Line, 150-ft. Spacing, 6,600 Volt.

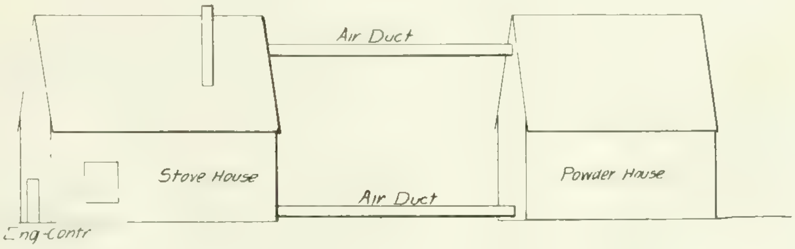
	From	To
72 35-ft. poles in place and framed, poles at $6.00 to $8.50 each delivered on cars	$ 620.00	$ 850.00
72 brackets with fittings in place	240.00	300.00
10,560 ft. No. .0000 trolley, 6,764 lbs., @ 20c to 26c per lb.........	1,352.00	1,758.00
10,600 ft. ⅜-in. high strength steel messengen cable	220.00	260.00
72 messenger insulators	30.00	60.00
72 spans cat. hangers..	80.00	144.00
10 anchors	17.00	30.00
300 ft. ⅜-in. strand for guy	3.50	4.00
20 steady braces for curves	60.00	80.00
20 strain insulators....	22.00	30.00
Per cent for handling material	130.00	160.00
Labor erecting 2 mi. catenary construction.	320.00	400.00
Labor erecting 3,000 ft. curve construction add	100.00	150.00
2 double track half anchorages	40.00	60.00
Siding construction pro rated	200.00	300.00
Lags, clamps, etc.	10.00	20.00
	$3,444.50	$4,616.00
Add for lightning protection	20.00	240.00
Add for gd. wire lgt. protection	150.00	400.00
Add for telephone line.	100.00	150.00
	$3,714.50	$5,406.00
If all poles are anchored	216.00	360.00
If all brackets are insulated	80.00	120.00
Total	$4,010.50	$5,886.00

In deciding whether the pole line for double-track shall be a double-pole line or a center-pole line, the character of the grading on the right-of-way will have to be taken into consideration. If, as in the Middle West, the country is practically level and no expensive cuts or fills are required, possibly the single-pole construction will show a saving over the double-pole; however, where there are expensive fills and cuts, the double-pole construction will show a saving over the single-pole, not in itself, but in the fact that the roadbed will not have to be as wide as for the single-pole construction.

The total output of the Colon and La Boca dredging divisions of the Isthmian Canal for the month of November was 782,720 cu. yds. The total amount of material taken from the Canal prism on the Culebra Division by steam shovels was 778,860 cu. yds. This shows an excess of nearly 4,000 cubic yards in favor of the dredging divisions.

Methods and Costs; Some Old; Some New.

Dynamite Thawer.—The accompanying sketch shows an easily made dynamite thawer used by the Tanana Railway Construction Co., which is building the Alaska Central Ry. As will be seen from the sketch the thawer consists of two houses, which are constructed about 20 ft. apart and are connected at the top and bottom by boxes. These boxes act as air ducts and keep up a circulation between the storehouse and the powder house. The air ducts and the powder house are usually covered with a fireproof roofing paper. We are indebted for the sketch and the above information to Mr. J. B. Cameron, Engineer of Construction of the Alaska Central Ry.



Sketch Showing Arrangement for Thawing Dynamite.

Data on Concrete Construction.—Reinforced concrete slabs were used in the construction of the plate vault roof of the U. S. Government Printing Office at Washington, D. C., completed in 1903. These slabs were supported on I-beams, with concrete protection around the beams. The average thickness, including concrete around the beams, was 9½ ins. The slabs cost $0.292 per sq. ft. or $10 per cu. yd. of concrete, some details of these costs being as follows:

	Per sq. ft.	Per cu. yd. concrete.
Cost of centering..	$0.066	$2.25
Cost of labor......	.0391	1.36

The span for the concrete floor construction was about 7 ft. The reinforced concrete slabs for the roof of the main building had an average thickness of 6 ins., and the surface was finished with a sanded coat of mortar about ¾ in. thick. These slabs cost $0.225 per sq. ft, or $11.97 per cu. yd. of concrete, some details of these costs being as follows:

	Per sq.ft.	Per cu. yd. concrete.
Cost of centering..	$0.037	$2.01
Cost of labor	.043	2.26

In all these figures for reinforced concrete the cost of centering includes all labor pertaining to it. The item "cost of labor" includes only the labor applied to the mixing and placing of concrete and the placing of steel. Of the cost of centering about two-thirds is for labor and one-third for materials. The ceiling slabs were made of Portland cement mortar, strengthened by small steel bars and supported at intervals of 2 ft. by light T irons laid on the lower flanges of the 3-in. I-beams. The total cost of these slabs was $0.126 per sq. ft., or $20.73 per cu. yd. Some details of these costs are as follows:

	Per sq. ft.	Per cu. yd. concrete.
Cost of forms.......	$0.016	$2.68
Labor, making slabs	.018	2.88
Labor, setting slabs.	.011	1.88

The slabs were set in place by bricklayers. Some of the wages paid per 8-hour day were as follows: Common labor, $1.50 per day; bricklayers, $4 to $4.50.

Filing and Indexing Office Records.—The following system of filing and indexing plats is used in the City Engineer's Offices in a number of New England cities. The system was first used in the City Engineer's Office at Providence, R. I., and is thus described by Mr. Otis F. Clapp of that city: Every plan, as soon as it is made, or if its preparation is to take long, as soon as it is begun, is entered in a day book, in which the lines are numbered from 01 up. These day book numbers represent the total number of plans made in the office, of whatever kind, for whatever purpose, or by whatever department. The numbers are printed on the left hand side of the book. On the right the two pages are ruled in columns with the following headings: Drawer and sheet number; title; made for; date; scale; kind of paper; size of sheet; field book and page; computation book and page; office number; field work by; platted by; drawn or copied by; receipted by; remarks. The last named column usually gives the day-book number of the plan copied from. Care is taken to have the first word of the description the most prominent word of the title, as the name of the street of which the plan forms a part, or the name by which the plan will be most easily recognized or thought of when wanted. Then follows a short and comprehensive description of what the plan represents, stating whether it is prepared for office use, or for what committee or purpose. The assistant who indexes the plan, having first determined in what drawer it should be placed, gets from the engineer's clerk in the "office number," which represents the number of plans actually on file in the office, regardless of departments, and also the last sheet number for the drawer in which he intends to file the plan. For this purpose the clerk keeps two books, one, called the "Index Drawer Number" book, containing the sheet number and office number; the other, called the "Index Office Number" book, containing the office number, drawer number, sheet number and day book number for each plan indexed, placed in the order of office numbers. The clerk's duty is to keep the work posted up to date. If he does so, he can tell the last office or sheet number used in every drawer in the office, and thus prevent the duplicating of numbers, which might happen if the last previously indexed should be missing from its place. Having thus obtained the day book, office, drawer and sheet numbers, he proceeds to stamp the plan. Each department has what is called a "Department Stamp," and the clerk has one called the "Miscellaneous Department Stamp." These stamps read: Providence, R. I., City Engineer's Office, ... Department, and each has a line for the date and one for the day book number. This stamp is placed at the upper right hand corner of the sheet.

Another stamp, called the Office Stamp, and containing the office number, drawer number and sheet number, is placed at the right hand lower corner of the sheet so as to be easily seen on opening a drawer.

The plan is next indexed in the "Department Index," each department having an index for its own plans, giving the day book, drawer and sheet numbers, the title or name as entered in the day book, the kind of paper and the office number.

The engineer's clerk posts the entries from the day book into a "General Index" under the name used in the day book (a street name, if possible), thus collecting together information concerning the location, etc., of all plans made for whatever purpose on that street or under that name. On the first day of January, 1905, 033552 day book numbers had been used, while on the same date the last office number used was 16,959. The difference of 16,593 represents the number of plans, copies, tracings or sketches made for committees or for construction, worn out or lost, etc. When a plan on file in the office is wanted outside of the office, the party taking it must sign a receipt for it, and this receipt is given up when the plan is returned. A record is also kept of such plans as are furnished and are not expected to be returned."

The total value of the lumber, lath and shingle production in the United States in 1906 amounted to $656,796,513.

LETTERS TO THE EDITORS

The Systematic Analysis of Cost Data

Sirs: I am much interested in what you say in your editorial columns about the value of cost data and particularly concerning the systematic analysis† of the same. Although I appreciate the fact that many of the circumstances which largely influence the cost of any piece of work are not capable of record, yet I am fully convinced that the method of analyzing cost into its elementary components is at once the sane and scientific one. Although such records will always be of greatest value to the observer, yet by this means they become intelligible to all. I should like to say, moreover, that your criticism regarding the lack of systematic study of such records in technical schools does not apply at the University of Colorado. Here the matter of cost is always taken up in class and its influence on design is pointed out.

So far as possible I have always kept cost records of work on which I have been engaged and submit the following to illustrate the agreement of costs on different pieces of work. Both jobs were done at Scranton, Pa.

The first job was a single track railroad culvert, containing 113 yards concrete and requiring 36 yards excavation, the cost of the work being as follows:

Cost of Material.

Kind and Amount of Material.	Unit Price.	Cost.
Stone, 113.2 tons	.70	$79.24
Sand, 46.8 yds.	.55	25.74
Cement, 137 bbls.	.85	116.45
Total		$221.43
Lumber		52.50
Rail and bolts		36.60

Excavation.

Labor, 189 hours @ .15	$28.33
Foreman, 60 hours @ .30	18.00
Total	$46.35

Concrete.

Labor, 683 hours @ .15	$102.45
Foreman, 130 hours @ .30	39.00
Total	$141.45

Forms.

Carpenters, 313 hours @ .225	$70.42
Labor, 30 hours @ .15	4.50
Total	$74.92

Handling Materials.

Moving material, 245 hours @ .15	$36.75
Unloading material, 95 hours @ .15	14.25
Foreman, 20 hours @ .30	6.00
Total	$56.90

Superintendence and Office.

Superintendent, 6 hours @ .50	$ 3.00
Office	10.00
Total	13.00
Grand total	$643.15

Proportional Costs.

Item.	Cost.	Cost Per Yard Concrete.	Percent of Total Cost of Concrete.
Concrete material	$221.43	$1.96	.371
Laying concrete	141.45	1.25	.236
Lumber	52.50	.46	.087
Rail and bolts	36.60	.32	.061
Building forms	74.92	.67	.133
Handling material	56.90	.50	.090
Supt. and office	13.00	.12	.022
Total		$5.28	1.000
Excavation	46.35	1.28	
	[illegible]		

Contractor's Receipts.

113 yds. concrete @ $5.95	$672.35
36 yds. excavation @ .30	10.80
Total	$683.15
Total cost	643.15
Profit, 5.9% of contract price	$ 40.00

The second job was the construction of a retaining wall, the costs being as follows:

Cost of Material.

Kind and Amount of Material.	Unit Price.	Cost.
Stone, 441 tons	.70	$308.70
Sand, 182.5 yds.	.55	100.37
Cement, 536 bbls.	.85	453.60
Total		$862.67
Lumber ¾ value		$205.33
Wheelbarrows, ¾ value, 6 @ $3.50		15.75
Total		$221.08

Excavation.

Labor, 4,002 hours @ .15	$600.30
Carts, 800 hours @ .125	100.00
Foreman, 460 hours @ .35	171.00
Water boy, 240 hours @ .10	24.00
Total	$895.30

Concrete.

Labor, 2,398 hours @ .15	$359.70
Foreman, 224 hours @ .35	77.40
Total	$437.10

Handling Material.

Unloading cars, 380 hours @ .15	$57.00
Foreman, 40 hours @ .35	14.00
Total	$ 71.00

Forms.

Carpenters, 997 hours @ .225	$224.33

Work to Support Bridge.

Carpenters, 542 hours at .225	$121.95
Labor, 458 hours @ .15	68.70
Total	$190.65

Superintendence and Office.

Superintendent, 30 hours @ .50	$ 15.00
Office	20.00
Total	35.00
Grand total	$2,937.13

Proportional Costs.

Item.	Cost.	Cost Per Yard of Concrete.	Percent of Total Cost.
Concrete material	$862.67	$2.02	.467
Laying concrete	437.10	1.03	.234
Lumber	205.33	.48	.113
Building forms	224.33	.53	.123
Handling material	71.00	.17	.038
Wheelbarrows	15.75	.04	.010
Supt., etc.	35.00	.07	.015
Total		4.32	1.000
Work on bridge	190.65		
Excavation	895.30		
	$2,937.13		

A study of the percentages of total cost show considerable uniformity in these two instances. On another job (a culvert), however, the cost of "laying the concrete" was doubled in percentage of the whole due to the necessity of wheeling the mixture up a gangway about 60 feet. This latter fact illustrates the class of circumstances which are not capable of record.

I find Engineering-Contracting of much assistance in furnishing material for class work, and am very much in sympathy with your laudable effort to make the *study* of cost data possible.

Yours very truly,
C. C. Williams,
Instructor in Civil Engineering.
University of Colorado, Boulder, Colo.,
Dec. 21, 1907.

---

†Engineering-Contracting, Dec. 4, 1907, p. 310.

The production of gold in Australia during the nine months ended September 30, 1907, was 2,713,522 fine ounces.

Practical Suggestions on Computing*.

BY RUSSELL TRACY CRAWFORD.

The first question to be considered by a computer is: How many decimals shall be carried, or how many figures are necessary in the logarithms in order that no error may creep into the result by accumulated errors of computation, i. e., errors arising from the logarithms themselves (neglected decimals, etc.). The choice of the number of decimal places that it will be necessary and sufficient to carry in any particular problem may well be an embarrassing one to the beginner, and possibly also to a computer of some experience. It is not at all uncommon to see the reduction of a set of observations based upon angles given only to the nearest minute of arc, carried through laboriously with a five or six-place table, and a result given to tenths of seconds of arc. The reader may well smile at such a ridiculous procedure, but it is done more often than not by the uninstructed beginner. The accuracy to which any particular table will give a result can be determined by the following simple analysis, which may be found in Newcomb's "Compendium of Spherical Astronomy."

Let a be the correct value of some quantity, and $a \pm s$ the value derived by computation, s being the error arising from the decimals dropped from the logarithm. We have for the error of the logarithm:

$$\log (a + s) - \log a = \log \frac{a + s}{a} = \log (1 + s/a).$$

Expanding the last term we have

$$\log (a + s) - \log a = M [s/a - \tfrac{1}{2} (s/a)^2 + \text{higher powers of } (s/a)],$$

where M is the modulus of the common system, $= 0.434-$.

Considering s so small that the higher powers of s/a may be neglected we have

$$\log (a + s) - \log a = M\, s/a.$$

The value of the unit in the last figure of an n-place logarithm is ten to the minus nth power. Let us assume an error of unity in the last figure of log a. Then

$$\log (a + s) - \log a = 1.10^{-n} = M\, s/a$$

and $s = a/M\ 10^{-n}$.

Making, now, n equal various numbers of decimals in logarithms we have the following corresponding errors in a,

Three-place logarithms,	$n = 3,\ s = \frac{10^{-3}}{M}\ a = \pm 0.0023a.$
Four-place logarithms,	$n = 4,\ s = \frac{10^{-4}}{M}\ a = \pm 0.00023a.$
Five-place logarithms,	$n = 5,\ s = \frac{10^{-5}}{M}\ a = \pm 0.000023a.$
Six-place logarithms,	$n = 6,\ s = \frac{10^{-6}}{M}\ a = \pm 0.0000023a.$

From this it is seen that the use of three-place logarithms gives a result correct to the 400th part of the correct value, four-place logarithms to the 4000th part and so on. It is safe, therefore, when an error of 1 per cent in the computed quantity is allowable in the reduction to use a three-place table. To reduce the error to 1/10 of 1 per cent use a four-place table, and so forth.

---

*Slightly condensed from the "California Journal of Technology" for October, 1907.

In using logarithms of the trigonometrical functions the following scale will be found useful for guidance. (This table can be found mathmetically and also, more easily, by inspecting the run of the differences in the particular tables.)

For	Use
Tenths of degrees..	Three-place logarithms
Minutes	Four-place logarithms
Tenths of minutes...	Five-place logarithms
Seconds	Six-place logarithms
Tenths of seconds..	Seven-place logarithms

To compute intelligently you should have some idea of the accuracy to be attained. Never use an m-place table for an $(m - 1)$ place computation. The extra labor involved in using one more decimal place in any case is very large. This is especially noticeable in passing from a five to a six-place computation. While interpolations may often be avoided by the use of the larger table the time lost and labor involved in turning the greater number of pages more than offset this one advantage.

It might be well at this point to give a list of good logarithmic tables and to continue with a few suggestions concerning logarithms. The following tables are highly recommended:

Newcomb, Three and Four-Place Logarithmic and Trigonometric Tables.

Newcomb, Five-Place Logarithmic Tables.

Hussey, Logarithmic and Other Mathematical Tables.

Bremiker, Logarithmisch Trigonometrische Tafeln. (Five-Place.)

Bremiker, Schsstellige Logarithmen.

Vega-Bremiker, Logarithmisch-Trigonometrisches Handbuch. Seven-Place.)

In Bremiker's Five-Place table the degree is divided into hundredths and not into minutes as is usually done. This arrangement will be found most useful and is earnestly recommended to the computer.

The importance of using addition-and-subtraction logarithmic tables cannot be too strongly impressed upon the computer. Once one has become used to them they seem indispensible. Their use is very simple and always indicated clearly in the tables themselves. As a rule, however, engineering students are entirely unfamiliar with them, so a few words of explanation here may lead to a more general application of them.

The problem is this: Given log a and log b, to find log (a + b). Without these tables the process would be to look up a and b respectively, add them and take out the logarithm of their sum, involving four operations. With the aid of the tables the solution is as follows, assuming a greater than b:

$$\log (a + b) = \log a \, (1 + b/a) = \log a + \log (1 + b/a).$$

The tables give log $(1 + b/a)$ with log b/a as argument. All that is necessary, therefore, is to form log b/a which is log b — log a (this can be done mentally and the resulting argument need not be written down) and with this number as argument take log $(1 + b/a)$ from the table. This is then added to log a, the larger of the two original logarithms, the resulting logarithm being log $(a + b)$. This process involves only two operations, a saving of one-half the time and labor necessary by the old method. The formation of log $(a - b)$ is similar, being a sort of converse proposition and need not be explained further here. The explanations accompanying the tables are very explicit. A little practice will render one quite proficient in their use. Once used they will always be used.

Always remember that in differential processes the expression $\frac{d \log x}{dx} = 1/x$ is true only when the base of the logarithm whose derivative is taken is e. In order to use the result in common logarithms, multiplication by the Modulus must first be performed.

In taking numbers from a table, group them in the mind thus: 9.837,465 or 9.83,74,65. Do not try to think of the correct order of seven numbers, but merely of two or three thus grouped. In using logarithms a fruitful source of error is the transposition of numbers in taking them from the table and writing them into the computation. Thus it is not uncommon to take from the table 9.4673 and write it down 9.4637.

In taking two numbers at once from a table (e. g. the sine and cosine of an angle) take care of one, the more difficult, by holding it in the memory temporarily by the grouping method just mentioned, and retain the impression of the other in the retina so as to reproduce it from the way it appears. It will take practice to do this successfully, but once the habit has been acquired it will save much time.

If a number is a fraction which contains several factors in the numerator and several in the denominator, do not form the logarithms of the numerator and denominator separately and then take their difference, but write down the cologarithms of the numbers in the denominator and add them all at once, thus saving one operation. Cologarithms are written readily by taking every number except the last from nine and the last from ten.

Avoid using negative characteristics by adding 10 to such a characteristic and then writing — 10 after the logarithm, or understand it to be written, as in the logarithms of sines and cosines in the tables.

When it is necessary to use a negative number in the computation, place a small n after its logarithm [e. g. log $(-2) = 0.30103^n$] and use extra care in handling such numbers, remembering that the sum of an even number of such logarithms is the logarithm of a positive number, etc

Once the question of the number of decimals to be employed is settled, the next thing to do is to consider the problem as a whole with a view to arranging the work in an orderly and economical manner and in such a way that another computer can comprehend it. After you have fixed upon the general arrangement, consider it in detail, writing out all of the arguments necessary in a vertical column or columns, placing together those numbers that are to be combined in the processes indicated in the formula. If several solutions of the same formula, but with different starting values, are to be made, make only one column of arguments and carry through the various operations simultaneously for all the different values assigning one column to the right of the column of arguments for each set of starting values. In case the solutions are for equidistant values of the starting quantities this method will afford a good control upon the correctness of the computation, for all the quantities in the same horizontal line ought to differ systematically as they read from one side of the computation across to the other. Finally an error (if it exists) in the final result may be detected by noting that the differences, when formed, do not run systematically. This is called checking by differencing. It will, of course, not show up any error that may affect all the columns in the same way. If a number is common to all the columns do not write it every time, but put it on a slip of paper and run this across the columns.

Once the arguments are written out, look down the column and note what trigonometric functions have to be used for any particular angle and take out the logarithms of all these functions at the same time regardless of where they may occur in the order of the arguments. This will save turning to the same page of the tables more than once. When the logarithms of the sine, cosine and tangent are taken from a table they should always be checked by noting that the logarithm of the tangent should be the difference between the logarithms of the sine and the cosine.

When a computation is not done in duplicate use all the checks possible. If none are known a computer's ingenuity will often enable him to devise some. This is especially important in a long or a very important computation. When checks are given or devised they should be investigated as to whether they are complete checks, i. e., both necessary and sufficient, or only partial checks, i. e., necessary but not sufficient. In a long computation the application of checks greatly relieves the mutual strain.

We shall now consider some points on the handling of trigonometric functions and a few suggestions which it is hoped will be helpful in ordinary arithmetical processes. In the first place, a computer should know perfectly the signs of the various functions in all four quadrants. There is no excuse for a loss of time in hesitating over them. Since the [illegible] of an angle varies more rapidly than the sine or cosine it is always best to determine an angle from this function. In looking up the sine or tangent of very small angles always use the S and T formulas, rather than interpolate values where the differences are large and run irregularly. It should be remembered that in the case of small angles, when the sine or tangent is replaced by the angle itself, the unit of the angle is the radian and to express it in seconds of arc the angle should be divided by sine 1" or tan 1" as the case may be; and further that the unit of a differential angle is the radian. When an abstract number is taken to represent an angle the unit is again the radian.

Often a small negative angle is replaced by 360 degrees minus the positive value of the angle, thus —10 degrees would be considered the same as 350 degrees. This is all right as long as we are using the trigonometric functions of the angle itself. But when it is necessary to use fractional parts of an angle this can no longer be done. In the case mentioned, for example, taking the half angle we would have for the one, —5 degrees and for the other 175 degrees and the trigonometric functions of these are entirely different. When the fractional angles come into the problem it is not safe, therefore, to call an angle which is negative, 360 degrees minus the positive angle. It should be considered $2n\pi$ minus the positive angle, so that after the fractional part is taken the angle is 2π minus the fraction of the positive angle. For example, if we have half angles to deal with we could consider 10° to be $4n\pi—10°$, so that the half angle becomes $2n\pi—5°$. This will be very evident when it is borne in mind that the period of the trigonometric functions is 2π.

A simple and time-saving device for looking up trigonometric functions of angles not in the first quadrant is as follows. For an odd numbered quadrant add the digits of the tens and hundreds of degrees. The sum will be the digit for the tens of degrees of the first quadrant angle whose functions should then be looked up, care always being taken to give the functions their proper signs according to the original quadrant. For an even numbered quadrant find the corresponding first quadrant angle as before and look up the co-functions of the respective functions of the original angle, care being taken as to the signs. If the sum of these digits is in either case nine or greater, subtract nine from the sum and use the difference as the digit for the tens of degrees. Example: Given 264° 5' 10". Add 2 and 6, giving 8. The corresponding first quadrant angle is then 84° 5' 10". The original angle is in the third quadrant, so we would look up the direct function of the first quadrant angle. Again: Given 284° 5' 10". The sum of the digits is now 10, subtracting 9 we have the corresponding first quadrant angle 14° 5' 10", whose co-functions we would look up. This method is much simpler than to subtract 90°, 180°, or 270° as the case may be, from the given angle in order to make the reduction. This may be proved as follows:

Every angle less than 1000° may be written, so far as its degrees are concerned, in the form (100a+10b+c) where a, b, and c may be any digits, so that,

$$\sin(100a+10b+c) = \sin[90a+10(a+b)+c]$$

$$\sin(100a+10b+c) = \cos[10(a+b)+c] \qquad \text{if a is 1}$$

$$\sin(100a+10b+c) = —\sin[10(a+b)+c] \qquad \text{if a is 2}$$

$$\sin(100a+10b+c) = \cos[10(a+b)+c] \qquad \text{if a is 3}$$

and similarly for the other functions. In case (a+b) equals or is greater than 9 we have a second quadrant angle and the reduction to the first quadrant angle is clearly made by subtracting 9 from (a+b).

For the determination of the quadrant the following rule is useful. It is the (a+1) quadrant when $(a+b) < 9$; the (a+2) quadrant when $9 \leq (a+b) < 18$; the (a+3) quadrant when $18 \leq (a+b)$ and so on. For example 532° is a sixth, (5+1), quadrant angle, the sign of the trigonometric functions of which are the same as those of a second quadrant angle. Again, 835° is in the tenth, (8+2), quadrant, and 995° is in the twelfth, (9+3), quadrant.

In interpolating make it a rule to interpolate from the nearest tabular value so as to avoid the use of large numbers. Example: Suppose you have to interpolate for .85 and the tabular difference is 79. Instead of turning to the table of proportional parts to take out .85 of the 79, you can form .15 of 79 readily without the use of the auxiliary table and subtract the result from the next higher value given, thus saving time and labor. Again, when the proportional part is, say, .16 or .17 take immediately one-sixth of the tabular difference rather than turn to the table of proportional parts. Break away from these auxiliary tables whenever possible by such devices as these. Care should always be taken to see that any short cuts introduced give correct results. In the last example, for instance, if the tabular difference is very large it is not safe to call .16, 1/6; or to call .14, 1/7, etc. The ability to tell at a glance when this can be done and when it cannot be done is one of the many things that tend to make a good computer.

In the arithmetical process of multiplication it would be well if the computer could multiply directly by numbers up to 20. Many multiplications that are done on paper could, with a little thought, be done mentally. For example, to multiply by 29, it is very easy to subtract once the number from 30 times the number, and the process can be done mentally with little effort. Again, to multiply by 98, take twice the number from 100 times the number and so on. For long multiplications, Crelles Rechentafeln will be found most useful.

In taking the mean of a column of numbers of approximately the same value, never add the column and divide by the number of numbers in the column. This takes too much time, A glance down the column will show you that the mean is roughly some number, say a. Then every number in the column may be written in the form (a+s). Summing these and dividing by n, the total number, we have

$$\text{Mean} = \frac{na+\Sigma s}{n} = a+\frac{\Sigma s}{n}$$

in order, therefore, to form a mean, guess at the approximate value, such as a, then form and add the residuals s as you proceed down the column. Divide this sum of the residuals by n and add it algebraically to the assumed a and the sum is the mean. Once you have this mean, form the correct residuals and check by noting that their sum is less than one-half n.

In working by Least Squares, always remember that your residuals must follow the error law, otherwise your solution means nothing. For a short series of observations it may be convenient to remember that an approximation to the probable error is two-thirds the average residual. For working Least Squares, Barlow's Tables of Squares will be found most useful. They give the squares, cubes, square roots, cube roots, and reciprocals of all numbers up to 10,000.

There are many special cases for short cuts which cannot be treated in a paper of this kind. They are quite sufficient to make a whole course on the subject.

Finally, never do on paper anything that can be done mentally. Much practice should be had on mental computing. On the other hand, never try to perform any operation mentally which will be a strain on the brain. Maximum efficiency in computing is attained by the proper combination of saving time and mental strain. The best adjustment for these is, of course, a function of the length of the computation. It is wise in general, to sacrifice speed for accuracy. But this must not be overdone else you will never become a rapid computer. One of the first essentials in a good quick computer is confidence.

In all cases strive to compute intelligently, not mechanically. Do not be discouraged with lack of speed at the start, but remember that as in all other things, "practice makes perfect."

In closing I desire to call attention, as a matter of historical interest, to the greatest three aids that have been introduced into computing. They are (1) the introduction of the Arabic system of numerals, (2) decimal fractions, and (3) the invention of logarithms. Of these three the first is the most important. If you don't believe it try to add, subtract, multiply or divide, MCMXCIV and DCCXVII.

Engineering-Contracting
Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review, timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purpose of the review index is: First, to inform civil engineers and contractors of the articles and papers of merit, that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The names, adopted abbreviations, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING-CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF TECHNICAL PUBLICATIONS.

American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in.; 15 cts.
American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.
American Carpenter & Builder (Am. Car. & Bldr.), Chicago, Ill.; m; 7x10 in.; 20 cts.
American Engineer & R. R. Journal (Am. Engr. & R. R. Jl.), New York, N. Y.; m; 7x10 in.; 20 cts.
American Gas Light Journal (Am. G. L. Jl.), New York, N. Y.; w; 10x13 in.; 10 cts.
American Machinist (Am. Mchst.), New York; w; 7x10 in.; 15 cts.
Annales des Ponts et Chaussees (Ad. P. & C.), Paris, France; m.
Architects & Builders Journal (Arch. & Bldrs. Jl.), Baltimore, Md.; m; 9x12 in.; 20 cts.
Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.
Architect & Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
Bulletin International Railway Congress (Bul. In. Ry. Cong.), Brussels; m; 50 cts.
Bulletin U. S. Geological Survey (Bul. Geo. Surv.), Washington, D. C., 4x7 in.
Bulletin U. S. Department of Agriculture (Bul. Dept. Agr.), Washington, D. C.; 4x7 in.
Bulletins Railway Engineering & Maintenance of Way Association (Bul. Am. Ry. Eng. & M. of W. Assoc.).
California Journal of Technology (Cal. Jl. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.
Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x10 in.; 20 cts.
Canadian Cement & Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.
Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.
Canadian Machinery & Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.
Canadian Mining Journal (Can. Min. Jl.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.
Canadian Municipal Journal (Can. Mun. Jl.), Montreal, Que.; m; 6¾x10 in.; 10 cts.
Carpentry and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.
Cassier's Magazine (Cas. Mag.), New York, N. Y.; m; 5x8 in.; 25 cts.
Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.
Cement Age (Cem. Age), New York, N. Y.; m; 4x7 in.; 10 cts.
Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.
Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.
Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.
Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.
Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.
Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.
Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.
Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.
Concrete Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.
Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.
Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.
Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.
Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.
Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.
Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.
Electric Railway Review (Elec. Ry. Rev.), Chicago, Ill.; w; 7x10 in.; 20 cts.
Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electric Traction Weekly (Elec. Trac. Wkly.), Cleveland, O.; w; 7x10 in.; 10 cts.
Engineer (Engr. Lon.), London, England; w; 4x11 in.
Engineer, (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Engineering (Eng.), London, England; w; 8x11 in.
Engineering Digest (Eng. Dig.), New York, N. Y.; m; 5x8 in.; 20 cts.
Engineering-Contracting (Eng. Contr.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Engineering and Mining Journal (Eng. & Min. Jl.), New York, N. Y.; w; 7x10 in.; 15 cts.
Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.
Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.
Engineering Record (Eng. Rec. New York; w; 8x11 in.; 10 cts.
Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.
Genic Civil, Paris, France; w.
Good Roads Magazine (Good Roads), New York, N. Y.; m; 7x10 in.; 10 cts.
Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.
Industrial World (Ind. Wld.), Pittsburg, Pa.; w; 7x10 in.; 10 cts.
Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; $1.
Insurance Engineering (Ins. Eng.), New York, N. Y.; m; 4x6 in.; 25 cts.
Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.
Iron Trade Review (Iron T. Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Irrigation Age (Irri. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.
Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.
Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.
Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.
Journal of Electricity, Power and Gas (Jl. Elec., P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.
Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.
Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.
Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Mines and Minerals (Mi. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.
Mining and Scientific Press. (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.
Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.
Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Modern Machinery (Mod. Mchy.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Municipal Journal and Engineer (Mun. Jl. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.
Municipal Engineering (Mun. Eng.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.
Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.
Pacific Building Engineer (Pac. Bldgr. & Engr.), Seattle, Wash.; w; 9x11 in.; 15 cts.
Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.
The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 ins., 15 cts.
Power, New York, N. Y.; m; 7x10 in.; 20 cts.
Proceedings American Institute of Electrical Engineers (Proc. Am. I. of E. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings American Society of Civil Engineers (Proc. Am. Soc. C. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings American Society of Mechanical Engineers (Proc. Am. Soc. M. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings Engineers' Club, Philadelphia (Proc. Engrs.' Club, Phila.), Philadelphia; qr.; 4x7 in.; 25 cts.
Proceedings Canadian Society of Civil Engineers (Proc. Can. Soc. C. E.), Montreal; m; 4x7 in.; 50 cts.
Railroad Gazette (R. R. Gaz.), New York; w; 8x11 in.; 15 cts.
Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.
Railway Age (Ry. Age), Chicago, Ill.; w; 7x10 in.; 10 cts.
Railway & Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.
Railway & Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.
Railway & Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.
Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Roadmaster and Foreman (Rd. & For.), Chicago, Ill.; 7x10 in.; 10 cts.
Rock Products (Rk. Prod.), Chicago, Ill.; bi-w.; 9x11 in.; 10 cts.
Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.
School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr.; 4x7 in.; 30 cts.
Schweizerische Bauzeitung, Zurich; w.
Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.
Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.
Sibley Journal of Engineering (Sib. Jl. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.
Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.
Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.
Street Railway Journal (St. Ry. Jl.), New York, N. Y.; w; 7x10 in.; 10 cts.
Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.
Waterproofing (W. P.), New York, N. Y.; m; 5x8 in.; 10 cts. .
Zeitschrift d. Oest. Ing. u Arch. Ver, Vienna; w.
Zeitschrift d. Ver Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

Street Sprinkling, Washington, D. C. Engr. Contr., Dec. 4; 1/3 p.

Wages and costs of operating sprinkling carts are given with total costs of street sprinkling for 1907.

Street Cleaning at Albany, N. Y. Egnr. Contr., Dec. 4; ½ p.

This article gives cost figures for cleaning cross walks and cobble stone pavement by hand and of cleaning by machine sweeping.

Street Lighting Contracts. By Alton D. Adams. Mun. Jl. & Engr., Dec. 4; 1½ pp.

Gives reasons why cities and towns should make short term contracts for street lighting and then only for gas or electric energy consumed in lamps of given types.

Dust Laying Tests. Mun. Jl. & Engr., Dec 4, 3 pp.

A general resume of methods and materials used in dust laying tests in a number of cities. Describes the methods used in treating with oil the roads in the West Chicago Park system and in Lincoln Park, Chicago, and also gives some information regarding experiments at Newport, R. I., with "Dustoline." The article also contains a resume of the work of the Metropolitan Park Commission of Massachusetts in treating roads with "Asphaltoilene" and Tarvia. Data on the costs of the various treatments are given.

Street Cleaning in Boston. Mun. Jl. & Engr., Dec. 11; 2½ pp.

A resume of the report of the Superintendent of the Street Cleaning Department of Boston, Mass., giving general information regarding street cleaning conditions in that city. Several forms used by the Street Cleaning Department in keeping track of work done are shown.

Costs to Electric Railway Companies of Street Work. Engr. Contr., Dec. 25; 1 1-3 pp.

General cost data are given of street sprinkling and cleaning, oil sprinkling and snow removal in various American cities as done by electric railway companies.

Cost of Road Treatment With Tarvia, Metropolitan Park Commission, Massachusetts. By J. R. Rablin. Engr. Contr., Dec. 18; 1 1-3 pp.

The author describes the method of applying tarvia and gives general figures of the cost of treatment during 1907.

Dust Suppression on Boston Parkways. By John A. Pettigrew. Good Roads Mag., December; 1 p.

A paper read Nov. 12, before the Massachusetts Highway Association. Describes the methods of laying dust with oil employed by the Metropolitan Park Commission.

Tests for Quality of Paving Bricks. By J. W. Howard. Good Roads Mag., December; 1 p.

A paper read before 1907 convention of American Society of Municipal Improvements, suggesting requirements and tests for paving bricks.

Specifications for Treating Wood Paving Blocks. By George W. Tillson. Good Roads Mag., December; 3 pp.

A paper read before the 1907 convention of the American Society of Municipal Improvements. Contains extracts of the salient points of the specifications under which treated wood block pavement has been laid in New York City, together with data regarding the present practice in several cities. The results of a test as to the volatility of oils of different specific gravity are also given.

Convict Labor Laws and Highway Interests. Good Roads Mag., December; 2½ pp.

A summary of the existing laws in the various states regarding the employment of convicts in public road improvement work.

Sand-Clay and Burnt-Clay Roads. Dept. of Agri. Farmer's Bulletin 311. By W. L. Spoon; 19 pp.; 5 cuts.

Shows the availability of these materials for wagon road construction. Describes principle of this class of work and gives in details the methods of constructing sand-clay, clay-sand and burnt-clay roads. Gives estimated cost of each kind of road and examples of roads of this character built in various counties and states, with the result of traffic on them, showing that they have proved successful. Bulletin written for farmers, but engineers interested in road construction will find it useful. Can be had free from Secretary of Agriculture, Washington, D. C.

Comparison of Cost of Gravel Roads in Maryland and Indiana. Mun. Eng., December, 2½ pages.

Figures are given showing the cost of materials and labor for gravel road construction in Maryland. Comparisons of cost of gravel roads in Maryland and Indiana are also shown. The figures are reliable but are not carefully analized.

SEWERS.

Baltimore's Sewerage and Sewage Disposal. Mun. Jl. & Engr., Dec. 4; 5 pp.

The city of Baltimore, Md., is now engaged in constructing a sewer system and has already let contracts involving the expenditure of nearly $3,000,000. This article treats of the tests made by the Board of Advisory Engineers which led them to recommend sprinkling filters for the purification of the sewage. Intermittent filtration was at first favored and various tests of available soils were made. Improved methods of making these tests were employed and a comparison of the results by the new and old methods are given. Investigations were also made concerning the effect upon bacterial treatment of sewage of different kinds of wastes which are discharged therein. Illustrations are given showing the testing apparatus and also the general layout of the sewage disposal testing plant.

Sulphur Sand Sewer Pipe Joints. Mun. Jl. & Engr., Dec. 4; ½ p.

Describes the methods employed by the Engineering Department of Newton, Mass., in making sewer pipe joints in wet trenches by the use of sulphur mixed with sand.

Sludge in Septic Tanks. Engr. Rec., Dec. 7, 1-3 p.

The result of sludge disappearance from septic tanks at Lawrence Experimental Station is given, taken from the report of the Massachusetts Board of Health. Records are given of concentrated sewage and the regular station sewage.

WATER WORKS AND HYDRAULICS.

Hydraulic Formulas: Development and Discussion. By Adolph Black. Schl. of Mines Quart., July, 24 pp.

A discussion of various Weir formulas and investigations to obtain and develop a general equation of discharge; and from it, as special cases, to derive the various formulas for glow through orifices and over weirs of the shapes usually considered. A very carefully written paper, and of use to those interested in hydraulic work.

Damages Caused by the Diversion of Water Power. By Clemens Herschel. Jl. New Eng. Water Works Asso., September, 7 pp.

Comments on the value of such damages from both the standpoint of the lawyer and the engineer.

Water Rights. By R. A. Hale. Jl. New Eng. Water Works Asso., September, 12 pp.

A discussion of water rights and their value, taking into consideration the diversion of water rights, the remarks being on the general subject on which the diversion matter depends. An 18-page discussion by members of the association follows this paper, the discussion also including papers by Clemens Herschel and Charles T. Wain.

Water Filter for South Norfolk, Conn. Mun. Jl. & Engr., Dec. 4; 4 pp.

General descriptive article on the new $70,000 water filter for South Norwalk, Conn. A number of illustrations show the filter in process of construction.

The Water Supply of Goldfield, Nevada. Eng. Rec., Dec. 7; 2 pp.

Describes the necessity of a water supply of this town, and how it was obtained. The feature of interest was the driving of tunnels in the mountains to intercept the underground flow of water, as shown by some springs, thereby increasing the original capacity of the springs by 60 to 100 per cent.

Gravity Water Supply System at Greeley, Colo. Eng. Rec., Dec. 14; 4½ pp.

A long descriptive article showing the necessity of a supply, and the construction of the headworks, sedimentation basin, slow sand filters (and the success obtained with them), the 36-mile wood stave pipe line, and the distributing reservoirs.

Water Power Development, Great Northern Power Co., Duluth, Minn. Eng. News, Dec. 26, 4 pp.

The article is a general description of the 30,000 h. p. hydro-electric plant already built by the company named and of the proposed other plants designed to develop an additional 170,000 h. p. The dams, pipe lines and power plant are described with map and general plans. The article is wholly general in character.

Computation of the Values of Water Powers, and the Damages Caused by the Diversion of Water Used for Power. By Charles T. Main. Jl. New Eng. Water Work Assoc. September; 26 pp.

A paper giving diagrams and formulae to determine the commercial value of water powers, and also for the diversion of water Of use to water power engineers and promotors.

Pipe Lines for Hydraulic Power Plants. Eng. Rec., Dec. 21; 2 pp.

A discussion on the economical design of pipe line for power plants by Arthur Jobson, abstracted from a paper read before the Telluride Institute. A formulae is derived to decide on the size of pipe that will give the least resistance to flow and at the same time will admit of reasonable cost.

The Chattanooga & Tennessee River Power Co. Plant. By Howard Egleston. Eng Rec., Dec. 7; 1 1-3 pp.

A description of the work necessary to construct this plant, and the use to which it will be put.

Raising a Dam at Lennep, Germany. Eng. Rec., December 28, 1 page.

The dam was of masonry and the article describes briefly the method of raising its crest some 10 ft. 7 ins. with new masonry supported by buttresses built on the downstream's face. The description is general.

Flow of Water in Open Conduits. By A. P. Merrell. Eng. Rec., Dec. 28, 2 1/3 pages.

An interesting mathematical discussion of the flow of water in open channels in which the author develops a new formula and gives comparative results of formula determinations and measured velocities

Diagrams to Determine the Bearing Power of Piles. By G. F. Stickney. Eng. Rec., Dec. 28, 1 page.

The author gives the official instructions and diagrams issued for determining the bearing power of piles on the New York State Barge Cement Work. The diagrams are for safe load for piles driven both by steam and drop hammers. The formula on which the diagrams are based are for drop hammer $L = 2\ w\ h \div (s + 1)$ and for steam hammers $L = 2\ w\ h \div (s + 0.1)$.

IRRIGATION AND DRAINAGE.

Method and Cost of Surveying and Reclaiming Wet Farm Land. By L. G. Hicks. Engr. Contr., Dec. 4; 2½ pp.

A valuable article on this important subject. The method of surveying for the work is described and the cost of surveying is given. The ditching and drainage work is described and the cost of each item listed. The tools used are illustrated. This is one of the best articles on this subject that has ever appeared in print.

Irrigation Ditch and Reservoir Linings. Eng. News., Dec. 5; 2 pp.

This is an abstract of bulletin No. 155 of the University of California, giving a progress report on studies of irrigation ditch and reservoir linings. Twelve methods of lining were experimented with; observations were made on the behavior of each lining and ratio of percolation determined and tabulated. General cost figures are given of the various linings.

RIVERS, HARBORS AND CANALS.

Schemes Showing the Possibilities of St. John, N. B., as a Great Port. By J. S. Armstrong. Trans. Can. Soc. C. E.; 16 pp. and 4 maps.

In all eight schemes are shown for the improvement of this harbor and the opening up of the adjoining country by canals and river improvement. Of interest to Canadian engineers and those engaged in harbor and river work. The details of the schemes are not given, only the general engineering features.

The New York Barge Canal. By L. T Bates. Yale Sc. Mthly, November; 9 pp., 7 cuts.

Article descriptive of the barge canal and of methods of doing earth and rock excavation and masonry work on contract No. 1, which is said to be representative of the canal work. The article is only of general interest.

RAILWAYS.

Steel Ties from Old Rails. By Jas. E. York. Ry. and Eng. Rev., Dec. 21; ½ p.

A letter from a correspondent who has designed various shapes that are rolled from old rails, thus utilizing worn out rails and improving the steel, as claimed by him, in his method of rolling.

Specifications for Bessemer Rails. Ry. and Eng. Rev., Dec. 21; 1 p.

Specifications given for Bessemer rails as adopted by the manufacturers of the United States and Canada. Open hearth specifications will be announced later. The American Railway Association has not yet approved these specifications, but it is expected that they will, as the committee drawing up the specifications had on it representation from the Association

Locomotive Shops, New York, New Haven & Hartford R. R. R. R. Gaz., Dec. 6; 4½ pp.

Shops capable of handling 45 locomotives a month are described in some detail with floor plans, sections and other general plans. Drawings of concrete locomotive pits are given, also general arrangement of scrap storehouse.

Engineering Features of the Parsons Shops of the M., K. & T. Ry. Eng. Rec., Dec. 7; 4 pp.

An article describing detail of fire protection, heating and power plant of these shops. Only a few features are of special interest, and these only to engineers and architects designing similar structures.

Locomotive Terminals, Chicago Junction Ry. R. R. Gaz., Dec. 20; 2 pp.

This article describes briefly the general arrangement of terminal for housing and repairing 45 locomotives. Drawings are given showing roundhouse engine pit construction in some detail.

Electrification of the Rochester Division of the Erie R. R. Am. Engr. & R. R. Jl., Dec.; 4 pp.

A general descriptive illustrated article on the installation of a single phase alternating current system of electric motive power on a steam railroad. The section of track electrically equipped is 34 miles long. Single phase cars are operated, power being received from a 60,000 volt transmission line.

Southern Pacific Improvements. Eng Rec., Dec. 14, 1 2-3 pp.

Tells of the improvements being made by this road between Sacramento and Truckie to tracks, sidings, snow sheds and freight yards, that have increased the officiency of the freight service.

An Efficient Smokejack. Ry. Eng. & Maint. Way., December; 2-3 p.

Description and cut illustrating jack used by the Chicago & Western Indiana R. R. with good results.

Standard Track Details. Ry. Eng. & Maint. Way, December; ¼ p.

Illustrates and describes rail joint with drawing giving dimensions as used on the C. W. & I. R. R.

Steel Rails. By F. E. Abbott. Cent. Ry. Club, November; 16 pp.

A description of steel rails is embodied in the paper from the mining of the ore, to the final rolling of the rail and placing it in the track for use. Comments are made as to how to improve the present rails being manufactured and prevent breaking of rails. The engineer is told the manufacturer's side of railmaking, design and use.

Transportation of Explosives. Proc. Am. Ry. Assoc.; 50 pp.

This report is of interest to engineers and contractors. Remarks are made on the dangers of transporting explosives and a list of the manufacturers of explosives and of distributing magazines are given. Also the rules and regulations adopted by the railroads for handling all kinds of explosives.

Economical Operation of Electric Signals and Maintenance of Batteries in Signal Work. By T. R. Cook. Proc. R. Sig. Assoc., 1907; 12 pp.

Description of experiment made to show the number of gravity cells to supply current to storage batteries for electric signal, dependent upon the number of operations in 24 hours, also the cost of the current. Recommendations are made as to care and maintenance, monthly and semi-annual inspection, and removing batteries from service. A number of diagrams, showing result of tests are given.

Valuation of Railways in Minnesota. Ry. Age, Dec. 20; 3 pp.

Statement of Charles F. Staples, member of the state railroad commission as to the work done by his commission in affixing a value to the railways of the state. A summary of the detailed information that the railways were required to give in the blanks furnished by the commission is given in the article. List of roads and their mileage is shown.

Cleveland Short Line Railway. Ry. Age., Dec. 20; 2½ pp.

Describes the belt line being built around the city of Cleveland. Illustrates the building of the Cuyahoga River Valley viaduct. The engineering features are mentioned but not described.

BRIDGES AND BUILDINGS.

Singer and City Investing Buildings, New York. Eng. News, Dec. 5; 6 2-3 pp.

The Singer building has 14 stories with a tower 41 stories (615 ft.) high. Typical floor and foundation plans and description of general structural features are given with particular account of tower wind bracing details. The drawings of the tower steel

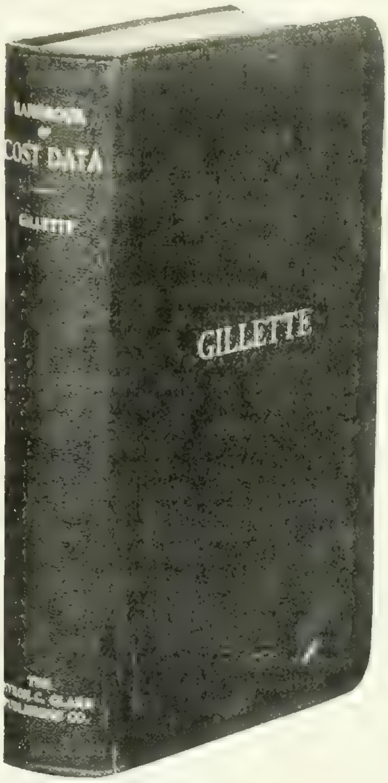
Handbook of Cost Data
By HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting"

"Costa Data" has broken all records for the sale of technical books. Over 10,000 copies were sold in less than two years; 1,600 in last three months. The book has over 600 pages of actual costs taken from the private records of engineers and contractors, and so itemized and analyzed as to be of inestimable value to any person who has to do with making bids and estimates or in checking estimates. This covers the whole field of contract work, giving the cost of labor and materials required for every kind of construction from the laying of sod to the building of reinforced concrete sewers. No detail of contract work has been too small to be described and recorded. Wages and prices of material are given in every case, so that proper substitution can be made where conditions differ. It gives also valuable data on methods of construction, thus enabling foreman to handle work in the most economical manner possible.

The general headings are:
Cost-Keeping, Preparing Estimates, Organization of Forces, etc.
Cost of Earth Excavation.
Cost of Rock Excavation, Quarrying and Crushing.
Cost of Roads, Pavements and Walks.
Cost of Stone Masonry.
Cost of Concrete Construction all kinds.
Cost of Water-Works.
Cost of Sewers, Vitrified Conduits and Tile Drains.
Cost of Piling, Trestling, Timberwork.
Cost of Erecting Buildings.
Cost of Steam and Electric Railways.
Cost of Bridge Erection and Painting.
Cost of Ry. and Topographic Surveys
Cost of Miscellaneous Structures.

24 Page Circular, showing Contents and Sample Pages, will be mailed FREE on request

THE MYRON CLARK PUBLISHING CO
355 Dearborn St. Chicago



work are of permanent value. The City Investing building has [illegible] stories with a 32-story tower, [illegible] ft. square. The main structural features are described in a general way, but the chief value of the article lies in the drawings of the foundation girders and portal girders and wind bracing.

Terra Cotta Fireproofing. Eng.-Contr., Dec. 4; ½ p.

The construction of terra cotta fireproofing for the U. S. Government Printing office at Washington, D. C., is described and costs are given of materials and labor.

Erection of the Anchor Arms of the Blackwell's Island Bridge. Eng. Rec., Dec. 21; 2 pp.

An article descriptive of the work done on this bridge to date. Tells the amount of steel erected, rivets driven and such like information. Also describes some of the erecting plant.

Working Stresses in Steel Construction. By. C. A. P. Turner, Eng. News, Dec. 12; 3 pp.

The author presents a mathematical and critical comparison of stresses allowed in structural specifications and works out a set of conditions to be satisfied in deciding upon permissible working stresses in steel structures.

Queens' Approach to the Blackwell's Island Bridge. Eng. Rec., Dec. 7; 3 pp.

A description of the structural steel work of the approach to this bridge with cuts to illustrate it.

The Woodbury Viaduct. Eng. Rec., Dec. 14; 1 2-3 pp.

An article describing and illustrating the structural features of the proposed new double track viaduct to be erected by the Erie & Jersey R. R. at Woodbury, N. J.

Failure Tests of Full Size Compression Members Made for the Pennsylvania Lines West of Pittsburg. By C. P. Buchanan. Eng. News., Dec. 26; 10½ pp.

This is a detailed report of compression tests made on full size bridge posts and chords; 19 tests extending over 14 years are recorded. The complete log of each test is given; loads, compressions and deflections are given in tabular form and are shown by diagrams. Views of the broken members are shown. Altogether the article gives the most complete series of full size compression member tests ever made public.

City Buildings Construction and Repair Department, Chicago. By W. D. Barber. Eng. News., Dec. 5; 2 1-3 pp.

A division of the Department of Engineering of Chicago, Ill., known as the Division of Construction and Repairs, has charge of all additions, alterations and repairs of buildings owned by the city. This article describes the organization of the division, the scope of the work done and the cost and efficiency of the work all as an argument in favor of the doing of such work direct by the city instead of by contract.

Erection of the Manhattan Approach of the Blackwell's Island Bridge. Eng. Rec., Dec. 28; 1½ pages.

Describes briefly the masonry and stone and terra cotta embedded steel approach at the Manhattan end. A general plan of the concrete mixing and handling plant is shown and general details of the concrete work are described. The article is wholly general in character.

CONCRETE AND REINFORCED CONCRETE CONSTRUCTION.

Concrete Bridge Abutments. By T. M. Fyshe. Can. Engr., Dec. 6; 3½ pp.

This is an extract from a paper read before the Canadian Society of Civil Engineers Oct. 17, 1907. It discusses the design of reinforced concrete abutments and draws comparisons of cost between reinforced and plain concrete abutments.

The world's authority on this great subject.
The most expensive book ever issued and sold for $5.00.

Concrete and
Reinforced Concrete Construction

By HOMER A. REID, Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; $5 net, postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete, on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter—material never previously published. This work is complete, up-to-date and original. No other book on concrete contains one-tenth so much of the very latest data on tests, theory and practice.

In a two-column review of this book, "Manufacturers' Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

Write for 16-page Table of Contents.

THE MYRON C. CLARK PUBLISHING CO.
(NOT INCORPORATED)
355 Dearborn St. CHICAGO

Reinforced Concrete Office Building. By J. P. H. Perry in Harv. Eng. Jl., November; 13 pp.

An article descriptive of the work done on the Eastman Kodak Co.'s new building in New York. The features of interest were the use of cast iron columns and structural steel front, while the rest of the building was of concrete. The cast iron columns are filled with concrete and reinforcing rods from the beams and girders run through the columns.

Molding Large Concrete Slabs. Engr. Contr., Dec. 4; 1 p.

This article describes the method of molding, construction of molds and concrete mixing plant for making 7x24¼x2¾ ft. reinforced concrete slabs for railway bridge floors. It also gives labor force and estimated cost of molding and placing the slabs.

Reinforced Concrete Building in Oakland, Cal. By E. L. Soule. Eng. Rec., Dec. 21; 2 pp.

Description of the design of the Hotel St. Mark in Oakland, Cal. Various details of the design are illustrated.

Traveling Forms for Constructing Concrete Lock Walls. Engr. Contr., Dec. 4; 1 p.

This is a brief description of the construction and operation of a traveling form used in constructing the concrete lock for the Charles River Basin Dam at Boston, Mass.

Molding and Testing Cement Pipe. Engr. Contr., Dec. 4; 1 1-3 pp.

This article is abstracted from a paper by A. E. Wright in the California Journal of Technology. It describes the method and cost of molding and laying 6-in. to 12-in. cement pipe for irrigation work. A simple device for testing pipes for leakage is described and results of a series of leakage tests are given.

Lime Lava Mortar. By F. W. Abbott. Eng. News., Dec. 5.

Mortar comprised of 1 part hydraulic lime, 1 part sand and 1 part "Tezontle," lava cinders made slow setting but satisfactory mortar for lining City of Mexico drainage tunnel. The Tezontle was ground in mortar pans and then it and the lime and sand were mixed in same pans.

Concrete Lining for Gunnison Tunnel. Engr. Contr., Dec. 18; 1 1-3 pp.

Costs of materials, mixing and placing concrete for a section of lining 440 ft. long are given as computed from data made public by the engineer of the U. S. Reclamation Service.

Tests of Lime and Cement Mixtures for Mortar. By H. B. Nichols. Eng. News, Dec. 5; 1/6 p.

Various percentages of lime were mixed with natural cement and with Portland cement and the mixtures tested for strength. All percentages of lime below 20% increased strength of natural cement, the gain averaging about 25%. Portland decreased in strength roughly in proportion to percentage of lime added; below 20% lime the decrease was not serious. A 50% lime Portland cement mixture hardened in 48 hours, so that it could be put under water without disintegration.

Reinforced Concrete Viaduct, Richmond & Chesapeake Bay Ry. Eng. News, Dec. 12; 3 pp.

A single track railway viaduct some 2,500 ft. long and 70 ft. high in places is described and illustrated by drawings of typical towers and girders. The descriptive matter is quite general in character, but an interesting table is given showing deflections under a test train.

Reinforced Concrete Addition to Telephone Exchange, Salt Lake City. By L. J. Mensch. Eng. News, Dec. 5; 1 1-3 pp.

A method of reconstructing new foundations and reinforced pilasters to carry three additional stories to a brick building is described. There are also some details of the method adopted for placing concrete in freezing weather.

Tests of Reinforced Concrete Beams. By A. N. Talbot, University of Illinois Engineering Experiment Station, Urbana, Ill. Paper, 4¼x7 ins.; 35 pp.

This pamphlet gives in detail the results of tests made on reinforced concrete beams to determine effect of quality of concrete, effect of method of loading, effect of repetitive loading and diagonal tension failures. The materials used and the method of making and recording the tests are described. Results of the various tests are given in tabular form and are shown by diagrams and a series of conclusions are presented. An abstract of this bulletin was published in Engineering-Contracting Dec. 25, 1907.

Estimating Cost of Forms for Reinforced Concrete. By R. E. Lamb. Conc. Eng., December; 1 p.

The author assumes an example of building work and outlines a proceedure to be followed in estimating the cost of the forms for floors, columns and roof, assuming first two sets of forms and second three sets of forms.

Concrete Storage Car House, Capital Traction Co., Washington, D. C. St. Ry. Jour., Dec. 21; 9 pp.

The construction of a car house 537x205 ft. of reinforced concrete is described with illustrations and drawings of track layout, general structural details, etc. The description is general in character. It is noteworthy because of the large size and elaborate character of the building.

Tests of Cement Joints in Joining Old Concrete to New. Eng. News, Dec. 12; ½ p.

This is an abstract from Annales des Ponts et Chaussees, part 3, vol. 27, 1907, giving results of tests made to show efficiency of cement joints in joining old concrete to new. The general conclusion is that a cement joint is an aid in connecting new concrete work to old and that whether this joint is used or not an excessive tamping of the new work near the joint will add appreciably to the strength of the connection.

Method of Designing 75 ft. Reinforced Concrete Girders. By C. E. Tirrell. Eng News, Dec., 12; 4 pp.

The author gives in detail the mathematics and method adopted in calculating and designing 75 ft. reinforced concrete roof girders for a garage.

Hoist and Car Plant for Mixing and Placing Concrete for Arch Viaduct. Engr Contr., Dec. 18; 2/3 p.

The plant described consisted of bucket hoists discharging into dump cars running along the work. The labor force is given with an estimate of the labor cost of mixing and placing.

Laying Concrete Base for Pavement Using Machine Mixer. Engr. Contr., Dec. 11; ½ p.

The construction of pavement base using a machine mixer is described, and the size of gang and its organization are given with an estimate of the cost of the work.

Mixing and Placing Concrete for a Tunnel Lining. Engr. Contr., Dec. 11; 2 pp.

The work described is a reinforced concrete lining for a tunnel 2,200 ft. long. The plant for mixing and handling concrete materials and concrete and the methods of doing the various parts of the work are described fully.

Engineering Features of Proposed Henry Hudson Memorial Bridge. Eng. Rec., Dec. 28, 2 pages.

The proposed Henry Hudson Memorial Bridge is a concrete structure 2,840 ft. long consisting of seven 108 ft. span arches and one main arch span of 703 ft. This report by Leon S. Moisseiff, engineer in charge, to C. M. Ingersoll, Chief Engineer, Department of Bridges, New York City, describes brief-

Cements, Mortars and Concretes

—Their Physical Properties

An up-to-date Compendium of Reliable Tests of Cements, Mortars and Concretes

By

MYRON S. FALK, Ph. D.

Instructor in Civil Engineering, Columbia University.

This book contains a very complete report of the results of tests made during the past fifteen years, and gives these results in tables and diagrams classified according to subjects. This is a reference book that should be in the library of every civil engineer. The contents include chapters on Chemical Properties of Cement, Physical Tests of Cement, General Physical Properties, Elastic Properties in General, Tensile Properties, Compressive Properties, Flexural Properties, Report on Uniform Tests of Cement by the Special Committee of the American Society of Civil Engineers, and Constitution of Cement.

Cloth, 6x9 inches; 184 pages; illustrated; price $2.50 net, postpaid.

Practical Cement Testing

By

W. PURVES TAYLOR, M. S. C. E.

Engineer in Charge of Philadelphia Municipal Testing Laboratories.

This is the first practical and exhaustive treatise on this important subject. It has already been adopted as a text-book by the University of Pennsylvania and other technical schools. Each chapter contains a minute description of the methods followed in the author's laboratory and many valuable suggestions as to the "how" and "why" of cement testing. The observations on the interpretation of results, one of the most difficult tasks of the novice, are especially pertinent and are expressed in a fair and conservative manner.

The book is so complete that it can be put in the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. The wealth of photographs and line cuts furnish the pictorial examples of how to conduct cement tests, and the 300 pages of texts are so explicit that even the most inexperienced man can soon learn the art of cement testing. Yet the book has not a superfluous paragraph. The list of chapters includes: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13) Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement than Portland, (16) Specifications (The Author's, Am. Soc. C. E.; Am. Soc. Test, Mtls.; Soc. Chem. Indust.; Corps Eng. U. S. A.; British Standard, Can. Soc. C. E.).

Cloth, 6x9 inches; 330 pages; 142 illustrations; 58 tables; $3.00 net, postpaid.

The Myron C. Clark Publishing Company
355 Dearborn St., Chicago

ly the engineering features of span, foundations, methods of construction, materials used and strains allowed, erection and inspection. The report is an argument in proof of the feasibility of constructing this the largest masonry arch span in the world.

Reinforced Concrete Chimneys. Eng Rec., Dec 28, 1 2/3 pages.

This is an abstract of the report of an investigation made by Sanford E. Thompson for the Association of American Portland Cement Manufacturers. The author gives a brief history of concrete chimneys, the results of investigations of portions of such structures, and discusses the effect of heat. A set of essential requirements for reinforced concrete chimney construction is given.

EARTH AND ROCK EXCAVATION.

Unloading, Moving and Setting Up Keystone Drills. By J. P. Hutchins. Eng. & Min. Jour., Dec. 14, 5 pp.

The author describes and explains in some detail the best methods to follow in unloading machines from cars, in moving them over roads, with the necessary road making, to the work and in setting them up ready for operation. The operating crew and its wages and tests of tools and equipment are given. The article is of great practical value.

Cost of Shaft Sinking, Goldfield, Nev. By P. E. Barbour. Eng. & Min. Jour., Dec. 14; 1/3 p.

Itemized costs are given of sinking 100 ft. of 4x8 ft. square set timbered shaft through rock. There were 108 ft. B. M. of timbering per foot of shaft and the total cost of sinking was $32.45 per ft.

Controlling Earth Slides. By H. Rohwer. R. R. Gaz., Dec. 13; 1 1/3 pp.

This paper reprinted from Bulletin No. 90, American Railway Engineering and Maintenance of Way Association, discusses methods of preventing and controlling earth slides in railway cuts.

Testing Placer Ground With Keystone Drills. By J. P. Hutchins. Eng. & Min. Jour., Dec. 21; 6 pp.

The author describes in detail the methods to be followed in making borings in various kinds of soil. The article is of great practical value.

Mining Sheet Ground in the Joplin District. By Dos. Brittain. Eng. & Min. Jour., Dec. 14; 2 1/3 pp.

The author describes in a general way the methods of shaft sinking and breaking out ore and gives some details of the methods of ore handling. Wages and cost of work are given.

Hydraulic Dredge Work, New York Barge Canal. By Emile Low. Eng. News, Dec. 5; 1 1/3 pp.

Illustrations and descriptions are given of the hydraulic dredge "Oneida." Working force and wages are given with figures of maximum output. Labor costs of operating the dredge during October and November, 1906, are given. According to these figures the labor cost per cubic yard was 50½ cts. in October and 30.8 cts. in November.

Railway Embankment Construction With Wheelbarrows. By Wilmer Waldo. Engr. Contr., Dec. 4; 1½ pp.

The author discusses the general cost of railway embankment construction with wheelbarrows and describes and gives records of output and costs of a piece work system of doing such work. Interesting comparisons of cost by piece work and by day labor are given.

Advantages of Oxen Over Horses for Short Hauls. By D. H. Winslow. Engr. Contr., Dec. 18; ½ p.

The author compares the cost of maintenance and the work done by horses and oxen and shows the cheaper cost of hauling by oxen.

"I would have given $1,000.00 for this book a year ago."—W. H. Burk, Knoxville, Tenn.

"FIELD SYSTEM"

By FRANK B. GILBRETH, M. Am. Soc. M. E.

WHO THE AUTHOR IS.—Frank B. Gilbreth is the contractor who has made the "cost-plus-a-fixed-sum-contract" famous. In order to handle contract work scattered all over North America, Mr. Gilbreth found it necessary to develop a system whereby his foremen would execute work properly, promptly and economically. The code of rules and instructions to his foremen, and the printed forms for their reports, were bound in book form, and this book Mr. Gilbreth called his "Field System." Mr. Gilbreth's contracts have covered the widest possible range. Railways, canals, dams, factories, office buildings, whole industrial towns, are among the works that he has executed.

WHY ENGINEERS SHOULD STUDY "FIELD SYSTEM."—Every engineer should know how to manage men, for, whether he confines himself to purely professional work or enters into business of executing construction work, his ambition should be to direct the men under him in a manner that will secure the greatest possible efficiency. A revolution in the art of managing men is now in progress. Direct personal supervision was once deemed essential. To-day, however, "system" is fast supplanting personal supervision. By "system" we mean printed or written directions for employes to follow, and daily reports that show what the employes have done. System of this sort has recently been extended to the field survey work of the U. S. Geological Survey. While Gilbreth's "Field System" is not a system for the management of surveys, for example, it is rich in suggestions that can be applied in the management of any kind of field work, whether employes are engaged in surveying or in construction. Its rules and methods are applicable to office work, in so far as the principles involved are concerned. The book, in brief, is a treatise on the science of managing men by system. No engineer who aims to be more than a subordinate can afford not to have this treatise, written by a man who is an acknowledged adept in managing men.

Hundreds of engineers have gone into the contracting business during the past few years, and there is room for thousands more. But if they are to succeed in any great measure, it must be by the intelligent application of system and cost analysis. Gilbreth's "Field System" does not cover the whole field, nor was it written to cover it, but it does cover a very important part of the field, and a part upon which practically nothing has ever been written.

WHY CONTRACTORS SHOULD HAVE "FIELD SYSTEM."—Mr. Gilbreth has done in contracting what Mr. W. L. Douglas and Mr. Marshall Field have done in the mercantile field. He has taken a class of work involving endless detail, and has reduced the handling of these details to a system by virtue of which economy in construction and celerity in performance are secured, regardless of place or men. Every one has heard the expression, "one-shovel contractor," meaning a contractor capable of managing only one steam shovel at a time. The "one-shovel contractor" is the antithesis of the contractor having a system. The "one-shovel contractor" receives daily reports, it is true, but his reporters are his two eyes. The "one-shovel contractor" has a code of instructions for his men, it is true, but his ready tongue is the only leaf of a code bound between the cover of two jaws. The day of the "one-shovel contractor" is not yet gone entirely, but it will pass rapidly away. Every contractor should have a field system of his own, embodying his own experiences and covering his own necessities, but in the developing of such a field system no contractor can afford not to study the work of Mr. Gilbreth.

COPIES OF "FIELD SYSTEM" STOLEN.—When it became generally known that Mr. Gilbreth had supplied his foreman and superintendents with printed instructions, copies of the book were bribed from his employes, and photographed page by page, from cover to cover. Other copies were "lost," and thus made way with entirely. Huge salaries were used to hire away Mr. Gilbreth's superintendents, for the purpose of getting not only their trained services, but for their knowledge of the contents of the "Field System."

MAKING THE BOOK PUBLIC.—Mr. Gilbreth's action in making public his "Field System" in its entirety is without precedent in the world of business. It is an act that puts contracting on the high professional level of civil engineering. The civil engineer discloses his method of designing a structure, his purpose being to assist other engineers in doing as well. In the interest of scientific advancement the engineer places on record what he has found to be economic or effective. In the same spirit—we may call it the modern American spirit—Mr. Gilbreth has permitted publication of his private code of instructions to his men—his "Field System." He believes that contractors, and, indeed, all professional business men, will become far more efficient as managers of men if such systems as this are disclosed. He believes that in the general rise of efficiency that will occur all those engaged in business will share. He believes that those who are best fitted to be leaders will remain leaders. Character, experience and ability will have the same relative weight as ever. In these beliefs every broad-minded man ought to concur.

China is a nation that worships "trade secrets." It is a nation of industrial mutes. Their arts and their manufactures are taught by father to son, and zealously guarded. There has been no pyramiding of improvements upon one original invention as a base. The Chinese do not lack inventive ability. They are merely cursed by the curse of secretiveness. Their industries are plastered with signs of "No admittance," and are mummified in consequence. In striking contrast with the Chinese method is the American method. Our doctors, or engineers and our men of science generally have never concealed their discoveries or their improvements. Latterly our business men have shown a recognition of the truth of the general proposition that it pays the individual to share his discoveries with the rest of his fellows. Such generosity, in the final analysis, is simply an enlightened selfishness. The publishers of Gilbreth's "Field System" urgently request other contractors and business men to come forward with their systems, and put them permanently on record. Let business men generally adopt the altruistic policy that actuates professional men, and in its prosperity America will soon rise as far above its present level as it now stands above the level of the Chinese Empire.

PRICE OF THE "FIELD SYSTEM."—The book has 200 pages, bound in leather, and its price is $3 net, postpaid. Order now, before the edition is exhausted.

THE MYRON C. CLARK PUBLISHING CO.

355 Dearborn Street, Chicago

Method and Cost of Loading Dump Wagons from an Ingeniously Designed Hopper. By J. C. Black. Engr. Contr., Dec. 11; 2 1/3 pp.

Illustrates and describes method of doing the work, showing savings effected. Gives some tricks for reducing costs of excavating earth with buckets from cellars, and gives cost of loading wagons with the hopper. Locomotive crane was employed to raise buckets from the excavation. A useful article.

The Method of Operating a Lobnitz Rock Cutter in Canal and Harbor Work. By Linden Bates, Jr. Engr. Contr., Dec. 18, 2 1/3 pp.

Describes the method of using this machine for breaking rock so that a dredge can handle it. Shows saving over drilling and blasting. Some records of work done with the cutter are given.

Cost of Digging Post and Pole Holes by Hand. Engr. Contr., Dec. 18; ½ p.

Method of doing this work described and size of holes given and compared with those dug with a digger or auger. Two examples of cost of work done are listed.

Surfacing and Dressing Earth Work. Engr. Contr., Dec. 18; ½ p.

Comment and recommendation as to specifications governing this class of work and some suggestions to those doing it.

MATERIALS OF CONSTRUCTION.

Preservation of Structural Wood for Railways. By Martin Schreiber. Elec. Trac. Wkly., Dec. 19; 2½ pp.

A general description is given of the various methods of preserving timber with longer accounts of the pressure and open tank methods in which some general figures of cost are cited.

Preservative Treatment of Fence Posts. By Howard F. Weiss. Forest service circular 117, Dept. of Agr.; 14 pp.

A circular showing methods of preservation in use, giving experiments made by the Forest Service, the results of treating posts, and also the cost of treatment. It is stated that the life of a treated post is five times that of an untreated one. What is said here of fence posts can be applied to telephone, telegraph and trolley poles.

Strength of Wood as Influenced by Moisture. By Harry Donald Tiemann. Forest Service Circular 108, Dept. Agr.; 42 pp.

The importance of this circular is shown in the opening paragraph where it states that by drying a piece of green spruce it is possible to multiply its strength four times. The paper is the result of tests extending over three years by the Forest Service. Various diagrams and tables are given. This circular is of interest to engineers.

Prolonging the Life of Mine Timbers. By John M. Nelson, Jr. Forest Service Circular 111, Dept. of Agr.; 22 pp.; 8 cuts.

Gives account of tests made in preserving these timbers from decay by treatment, and results obtained. Also gives diagram and description of small commercial plant for treating timbers. This will be of value to engineers interested.

TIMBER.

Consumption of Cross Ties in 1906. Forest Service Circular 124, Dept. of Agr.; 6 pp.

This circular gives the number of cross ties purchased during the year for both steam and street railways. Also the various kinds of wood these ties were hewed or sawed from, with the cost of each. The average cost per tie was 47 cts. A comparison of the consumption of 1905 and 1906 is made. The number of treated ties purchased during the year is also given. This circular is for free distribution.

The Drain Upon the Forests. By R. S. Kellogg. Forest Service Circular 129, issued by Department of Agriculture; 16 pp.

A circular showing the yearly consumption of timber and wood of all kinds, by states and for various purposes. Diagrams illustrating the consumption are given. An estimate is made of the growth of timber, which shows the drain on the forests is three times as great as the supply.

Strength of Structural Timber. By W. Kendrick Hatt. Forest Service Circular 115, Dept. of Agr.; 39 pp.

Result of tests made by the Forest Service at their various laboratories on timbers used in structural work in U. S., namely, loblolly pine, longleaf pine, tamarack, Norway pine, Douglas fir, and western hemlock. Tests were of two kinds; tests on large beams, for studying the relations between strength, defects, and degree of seasoning, and for determining moduli for design; and tests on small pieces cut from uninjured parts of the tested beams, showing bending tests, compression tests, parallel and at right angle to grain and shearing. Results in detail are set forth and various tables are given. Longleaf pine was found to be the strongest and stiffest of all timbers named. These tests are among the most valuable ever made with timber and engineers designing timber structures will find them of interest.

SURVEYING AND DRAFTING.

Mine Surveying with Special Reference to Shaft Surveying. By C. E. Morrison. Schl. of Mines Quart., November; 12 pp.; 5 cuts.

A very good paper on this subject. Remarks are made regarding mine surveying that are useful to the student. Then shaft surveying is described in detail, record of notes given and the mathematics of an example illustrated. This article is not only of use to mining engineers, but also to the civil engineer doing tunnel work by means of shafts.

Standard Topograpnical Signs. Eng. Rec., Dec. 21; ½ p.

Shows signs adopted by the engineering department of the Board of Water Supply of New York for designation of topographic features on their maps.

Tests of "Invar" Steel Tapes. Eng. News, Dec. 5; ½ p.

"Invar" is a nickel and steel alloy with a very small coefficient of expansion. Tests to determine the suitability of tapes made of "invar" for base line measurement were made by the U. S. Court and Geodetic Survey, and results reported by O. B. French in Proc. Am. Soc. C. E., October, 1907, from which this account is abstracted. Mr. French concludes that invar tapes form the most economical and most accurate apparatus available for measuring primary base lines. Tests showed tensile strength of 100,000 lbs. per sq. ft., yield point 70,000 lbs. per sq. in., coefficient of expansion 0.00000023 per degree Fahrenheit.

TUNNELS AND SUBWAYS.

Three Colorado Trans-Continental Tunnel Projects. By George J. Bancroft. Ming. Science, Dec. 19; 2 pp.

Descriptive of tunnels now being built and proposed through the continental divide for mining transportation and water diversion. Plan shown for a tunnel to take both transportation and water.

Subway New York City. By S. U. Hopkins, Harv. Eng. Jl., November, 19 pp.

First of a series of articles telling of the history of the subway, the building and engineering features and the equipping and operation of this rapid transit line. Of interest to engineers and contractors.

Rotherhithe Tunnel Under the Thames River, London. By E. H. Tuber. Eng. News, Dec. 19; 5 pp.

The author gives a list of the tunnels built under the Thomas River at London and describes with copious illustration the structural features and general method of

Rock Excavation

Methods and Cost

By

HALBERT P. GILLETTE,

M. Am. Soc. C. E. Editor "Engineering-Contracting."

One superintendent who purchased this book about a year ago writes us that he has cut the cost of his drilling and blasting practically in two since he received the book and applied the methods given by Mr. Gillette. We doubt whether such a statement has ever before been truthfully made of any books except those written by Mr. Gillette. His books are practical books for practical men, and the keynote throughout is economy—how to save money on the work and how to increase the output.

"Rock Excavation" has chapters describing:

Rocks and Their Properties.
Methods and Cost of Hand Drilling
Machine Drills and Their Use.
Steam and Compressed Air Plants.
The Cost of Machine Drilling.
Cost of Diamond Drilling.
Explosives.
Charging and Firing.
Methods of Blasting.
Cost of Loading and Transporting Rock.
Quarrying Stone.
Open Cut Excavation.
Methods and Costs on the Chicago Drainage Canal.
Cost of Trenches and Subways.
Subaqueous Excavation.
Cost of Railway Tunnels.
Cost of Drifting Shaft Sinking and Stoping.

Cloth, 5½x7 in., 384 pages, 56 figures and illustrations; $3 net postpaid.

Earthwork

And Its Cost

By

HALBERT P. GILLETTE,

M. Am. Soc. C. E. Editor "Engineering-Contracting."

A book that should be in the hands of every man who is in charge of "moving dirt," whether with pick and shovel, plow and scraper, steam shovel and dredge, or any other tool for digging and conveying earth. The contents include:

The Art of Cost Estimating.
Earth Shrinkage.
Earth Classification.
Cost of Loosening and Shoveling.
Cost of Dumping Spreading Rolling
Cost of Wheelbarrows and Carts.
Cost by Wagons.
Cost by Buck and Drag Scrapers.
Cost by Wheel Scrapers.
Cost by the Elevating Grader
Cost by Steam Shovels.
Cost by Cars.
How to Handle a Steam Shovel Plant.
Summary and Table of Costs.
Cost of Trenching and Pipe Laying.
The Cost of Hydraulic Excavation.
Cost of Dredging.
Miscellaneous Cost Data.
Earth and Earth Structures.
Rapid Field and Office Survey Work
Overhaul Calculation.
A Small "Home Made" Dipper Dredge or Steam Shovel
Detailed Description and Drawings
Cost of Making the Dredge.
Cost of Operating.

Cloth, 5x7½ in., 260 pages, 50 figures and illustrations; $2.00 net postpaid.

The Myron C. Clark Publishing Co.

335 Dearborn St., CHICAGO

construction of the Rotherhithe Tunnel. The principal features of interest in the work are the use of the pilot tube method of work and of a mechanical excavator for removing the clay in advancing the pilot tube. The average rate of progress was 13½ ft. per 24 hours.

Loetschberg Tunnel. Eng. News, Dec. 5; 2 1-3 pp.

The Loetschberg Ry., 36 miles long, connects the north end of the Simplon tunnel with the railways of France. The tunnel is double track and 8½ miles long. A map and profile are given of the tunnel line and railway and the general character and conditions of the work and the arrangements being made for prosecuting it are described.

Alpine Railway Tunnels. Eng. News, Dec. 5; 3 pp.

Editorial discussing commercial aspects of present and proposed Alpine railway tunnels with a map showing locations of some 20 tunnels and their connecting railways and a table of lengths, dimensions, cost, progress, grades, etc., of the Mt. Cenis, St. Gothard, Simplon and Arlberg tunnels. The map and table are of permanent value.

Caisson Work for the Paris Subway. Comp. Air, December; 2 pp.

An illustrated article describing the caisson for the tunnel of the Paris subway under the river Seine. Metal caissons, composed of a tunnel section and a caisson proper, are assembled on shore, towed to place and sunk, after which the various sections are connected. This method saves driving a tunnel under the river bottom.

Compressed Air On the Belmont Tunnel. Compressed Air, December; 4 pp.

Description is given of the air plants and pumping plant erected by the contractor to drive this tunnel between New York and Long Island.

ELECTRIC RAILWAYS.

Reconstructing the Power System of the New Orleans Railway & Light Co. St. Ry. Jour.; 13 pp.

This article summarizes and describes the work done in centralizing the generating stations for railway, lighting and power requirements in New Orleans. General drawings are given of the main power station, terminal houses and substations.

Transmisison Line Construction for Interurban Electric Railways.. Eng. Cont'r, Dec. 11; 1 1-3 pp.

This article abstracted from the "Electric Traction Weekly" describes the standard methods of pole transmission line construction and gives estimates of costs in detail for three styles of construction.

Atlantic Shore Line Electric Railway. St. Ry. Jour., Dec. 14; 7 pp.

The Atlantic Shore Line comprises a series of electric railways reaching from Portsmouth, N. H., to Biddeford, Me., and connecting Boston and Portland. The general track and line construction of these roads is described briefly.

GARBAGE AND CITY WASTE DISPOSAL

Municipal Refuse Disposal. By J. T. Fetherston. Proc. Am. Soc. C. E., Dec. 18, 1907; 44 pp.

An account of an investigation conducted to determine the best means of disposal of the refuse of the Richmond Borough, City of New York. Description and results of various tests made are listed. Account of visits to refuse plants in England, Scotland, Wales and Canada, with the results obtained there are given. Costs and results of destruction of refuse are discussed. As a result of the investigation a mixed refuse destructor was recommended for the Borough of Richmond.

The Disposal of Municipal Waste. By W. F. Morse, Mun. Jl. & Engr., Dec. 4; 4 pp.

The concluding article of a series of articles begun in February, 1906, and printed in

Books on Cement and Concrete

Concrete and Reinforced Concrete Construction. By Homer A. Reid.

A complete and comprehensive treatise dealing with both theory and practice. Contains working drawings of all classes of construction.

906 pages; 715 illustrations; 70 tables. Price, net $5.00

Practical Cement Testing. By W. Purves Taylor (Engineer in charge Philadelphia Municipal Testing Laboratories.

Covers a description of the properties of cement; the objects of the various tests and methods of conducting them and the practical interpretation of the results obtained.

6x9 in., 315 pp., 142 illustrations, 58 Tables. Price, net $3.00

Cement and Concrete. By Louis C. Sabin.

Treats of the manufacture, properties and testing of cement, and the preparation and use of cement, mortars and concrete, and application to practical construction.

504 pages, 161 Tables of Tests. Price net $5.00

Treatise on Concrete, Plain and Reinforced. By Frederick W. Taylor and Sanford E. Thompson.

Contains much valuable data on cement and concrete and its practical application to construction work.

6x9 in., 584 pages, 172 illustrations, many Tables. Price $5.00

Cements, Mortars and Concretes. By Myron S. Falk (Instructor in Civil Engineering in Columbia University).

A classification and summary of reliable data concerning the physical properties of cement and cement mixtures.

6x9, 184 pages, 4 Half-tones and many Illustrations. Price, net $2.50

Reinforced Concrete. By A. Considère. Translated from the French by Leon S. Moisseiff.

Tests and data on reinforced concrete.

185 pages, 20 Figures. Price, net, $2.00

Reinforced Concrete. By A. W. Buel and C. S. Hill.

A mathematical discussion and practical consideration of constructions of reinforced concrete.

6x9 in., 434 pages, 311 Illustrations. Price, net $5.00

Reinforced Concrete. By Charles F. Marsh.

A theoretical and practical discussion of concrete structures.

7¾x11 in., 530 pages, 511 Illustrations. Price, net $7.00

Experimental Researches Upon the Constitution of Hydraulic Mortars. By H. Le Chatelier. Translated by Joseph L. Mack.

A chemical and mineralogical study of cement composition.

128 pages. Price, net $2.00

Calcareous Cements. By Redgrave and Spackman.

Contains much historical matter and a description of English methods of manufacture and testing.

Second Edition, 254 pages, 63 Plates. Price, net $4.50

Concrete Steel. By W. Noble Twelvetrees.

A discussion of fundamental principles of reinforced concrete construction.

218 pages, illustrated Price, net..$1.90

Hand Book on Reinforced Concrete. For Architects, Engineers and Contractors. By F. D. Warren.

268 pages, many Tables and Diagrams. Price, net $2.50

Cement Industry. A description of Portland natural cement plants in the United States and Europe.

235 pages, 132 Illustrations. Price, net $3.00

Cements, Limes and Plasters. By Edwin C. Eckel.

A description of cement materials and processes of manufacture.

6x9 ins., 712 pages, 165 Figures, 254 Tables. Price, net $6.00

Hydraulic Cement. By Frederick P. Spalding.

The nature and testing of cement.

298 pages, 31 Figures. Price.....$2.00

Portland Cement, its Manufacture, Testing and Use. By David B. Butler.

Gives English methods and practice in manufacturing and testing.

6x9 ins., 406 pages, 97 Illustrations. Price, net $5.25

Graphical Handbook of Reinforced Concrete Design. By J. Hawkesworth.

A series of plates, showing graphically. by curves, the required design for slabs, beams and columns.

Price, net $2.50

Cost Data. By Halbert P. Gillette, Editor Engineering-Contracting.

Costs of concrete, and concrete steel structures.

4½x7 ins., 622 pages, Illustrated. Price, net $4.00

General Specifications for Foundations and Substructures of Highway and Electric Railway Bridges. By Theodore Cooper.

7x9½ ins.; 50 pages, including 13 plates. Price $1.00

THE MYRON C. CLARK PUBLISHING CO.
355 DEARBORN ST., CHICAGO, ILL.

the first number of each month. The article gives a revised table of calorific values and treats of the utilization of calorific values in municipal waste. The question of collection service by contract and municipal agency is also discussed.

CONTRACTS AND SPECIFICATIONS.

Law of Contracts, a Lecture Before the Association of American Government Accountants. By John Mason Brown; 50 pp; pub. by author.

A book showing some of the essentials of contracts made between the U. S. Government and individuals and corporations. Shows who can make contracts, kinds of contracts, performance and discharge, and many other details of government contracts. Of use to engineers in the government service and contractors doing work for the Federal Government.

Contracts and Specifications. By Charles Evan Fowler. Course of lectures at the University of the State of Washington; 66 pp.

Eight lectures, touching on relations between the engineer and contractor, forms of contracts, specifications, inspection of work, estimating materials and costs and bidding on work. Meant as timely advice to young engineers, but some of it will be found applicable to older men in the profession.

Ambiguous and Onerous Specifications for Rock Excavation. Eng. Contr., Dec. 18; 1-3 p.

Comment on specifications containing such clauses, showing the injustice done to both parties of the contract by them.

MISCELLANEOUS.

Cost of Constructing Steam Driven Electric Power Plants. By Frank Koeslir. Engr. News, Dec. 19; 1 1-3 pp.

The costs given are per kilowatt capacity and represent an average arrived at by the comparison of costs of various plants with which the author has been connected. The several components of the average plant are discussed separately and the author tabulates separately the costs of turbine driven and reciprocating engine plants.

Design of Power Plant Chimneys. By Frank Kingsley. Engr. Rec., Dec. 21; 3½ pp.

A discussion of formulae for stack design, gives formula and diagrams based on the observations of the author. An interesting article.

Derrick Wagon for Pulling Poles. Elec. Trac. Wkly., Dec. 12; ½ p.

Illustrations and brief description are given of a special derrick wagon used in pulling up butts of poles. It has pulled piles 10 to 16 ft. deep in hard clay in 1 minute.

Curb for Wading Pools. Mun. Jl. & Eng., Dec. 4; ½ p.

Describes the concrete curb built around the wading pools in parks at Fall River, Mass., in order to prevent the washing out of the walks.

Stone Crushing Plant at the Menard, Ill., Penitentiary. Engr. Rec., Dec. 21; 1 1-3 pp.

An article descriptive of the stone crushing plant and storage bins in use at this penitentiary, where the convicts are employed in quarrying and crushing stone.

Some Pile Driving Experiments. By J. Albert Holmes. Harv. Engr. Jl., Nov.; 6 pp.

An interesting account of some experiments made as to loads carried in piles made in connection with the construction of the Charles River dam. Some piles were redriven after hours of setting, others were loaded with pig iron. Resistance to driving in various soils was recorded. Only results of experiments are given, the writer refraining from drawing conclusions. A paper of value.

Retaining Wall on the D. L. & W. R. R. at Buffalo. Engr. Rec., Dec. 21; ¾ p.

Describes these walls, their design and construction. Built of reinforced concrete, and plans showing their construction are included in the article. Of interest to designers and builders of concrete work.

Laying Underground Conduits. Engr. Contr., Dec. 4; 1 2-3 pp.

This is an abstract of a paper read by W. F. Roberts before the Engineering Association of the South. Various kinds of conduit are described and illustrated and general methods of conduit construction are outlined.

BOOK REVIEWS.

Field System. By Frank B. Gilbreth. Chicago, Ill. Myron C. Clark Publishing Co., Flexible leather; 4¼x6¾ ins.; pp. 194; illustrated; $3.

The prominence and popularity given to the cost-plus-a-fixed-sum method of contract by Mr. Frank B. Gilbreth, the author of this book, is well known to our readers. Field System contains the written ideas of the most successful men in his employ. It was compiled with the following aims in view: (1) To have the best practice in all departments put in writing for the benefit of all employers; (2) To avoid repeating orally, by putting in writing, all these instructions from which there are no exceptions. (3) To maintain the policy that the best work will in the long run bring the most profit, success and satisfaction.

So much for the purpose of the book. The contents may be described briefly as the certified rules, instructions and working data essential in carrying on general contracting work. The care of plant, machinery and tools, the methods of doing all classes of work, the system of keeping records of materials, labor, supplies and costs of all kinds are considered in detail. The items are too numerous to permit of their being listed here, but they include practically all parts and kinds of construction work.

It is expecting too much probably to expect that all the rules and instructions that the author of the book has found necessary in his work will be necessary to every contractor's work, but we are safe in saying that no contractor can read this book without getting hints and suggestions which will prove of value in his work, whether it be general in character or limited to one field. The book is a vauabe one for contractors and for engineers having charge of construction work. The publisher's work on the book is generally good, the illustrations are clear and there is an ample index.

Investigations of Centrifugal Pumps, Part I. A Discussion of the Theory of the Centrifugal Pump and Tests of a 6-inch Vertical Centrifugal Pump. By Clinton Brown Stewart. University of Wisconsin, Madison, Wis. Paper 6x9 ins.; pp. 588; illustrated; 50 cts.

Referring to the theory of the centrifugal pump, the bulletin discusses the general theory as ordinarily given for deriving the theoretical head developed by the impeller of a centrifugal pump, and shows how the various conflicting formulas ordinarily given are essentially the same in result.

The experiments with the 6-inch vertical centrifugal pump were arranged specially to investigate the effect, on the discharge and efficiency, of the number and shape of the vanes of the impeller of the pump. For this purpose the impellers to be compared were made of the same general size so as to be easily placed in the same pump casing, while the number and shape of the vanes of the impeller were varied. The general shape of the vanes used was radial, and radial with curved entrance, while the

Railroad Location Surveys and Estimates

By F. LAVIS, M. Am. Soc. C. E.
Resident Engineer, Pennsylvania Railroad Tunnels, Formerly Locating Engineer, Choctaw, Oklahoma & Gulf Railroad, etc.

The "Railroad Gazette" says: "Once in a while a scientific book appears that combines the threefold elements of mastery of the subject, clearness of expression and elegance in the use of English, a combination as rare as it is attractive. The book at hand is of this sort, and the interest of the reader or student is held through every line of the text. *It is one of those rare productions in which there is not a wasted word and whose scientific value is high in that it tells clearly and concisely just what every student and engineer should know.*"

Cloth, 6 x 9 in., 270 pages, 73 illustrations, 10 folding plates; $3 net, postpaid

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

Over 10,000 Copies
OF GILLETTE'S HANDBOOK OF
COST DATA
were sold during the first 22 months. This book is invaluable to any person interested in construction work of any kind.

Flexible leather, gilt edges, 622 pages, illustrated; $4.00 net postpaid.

24-page circular, showing contents and sample pages, also catalogs giving information concerning all classes of books for contractors and engineers will be mailed
FREE
Tell us in what you are interested.

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

Tables of Five Place Squares and Logarithms of Feet, Inches and 32ds of Inches From Zero to 100 Feet

Logarithmic Secants for Hip, Valley and Rafters from Zero to 18 inches; rise of 1-foot base advancing to 32ds.

Logarithmic Functions, Natural Sines and Cosines for every minute of the quadrant.

By
G. D. INSKIP

The Only Book Giving These Values to 100 Feet

Engineers, draftsmen, editors—all who have investigated the matter—say that this is the **best book of its kind that has ever been published.**

WRITE FOR SAMPLE PAGES

Flexible leather, tape bound, 5½x7½ inches; 280 pages; price $3.00 net, postpaid.

The Myron C. Clark Publishing Co.
355 Dearborn Street, CHICAGO

number of vanes for each shape was varied, being 6, 12 and 24 in number. The form of water way between the vanes was also varied by increasing the thickness of the outer ends of the vanes. The comparison of the results of the experiments thus show the effect on discharge and efficiency of the pump of practically all possible modifications of the simple radial vane. The pamphlet contains a descriptive index of all the more important articles and books that have been published on centrifugal pumps.

SHAFT SINKING UNDER DIFFICULT CONDITIONS. By J. Riemer; translated from the German by C. R. Corning and Robert Peele. John Wiley & Sons, New York. Book, 6x9 ins., 178 pp., 18 engravings and 19 plates.

This is a book that will be used by both mining and civil engineers engaged in shaft sinking. For the most part the text is descriptive of actual shaft sinking that has been done in Europe under trying and difficult circumstances. The unwatering of the ground is discussed and shaft sinking by hand. Then is described the method of sinking a shaft by boring, a method that is similar to drilling an artesian well, only the hole is made feet wide in diameter instead of inches. Shaft sinking by the freezing process is described by six examples, and the treatise closes with a chapter on drop-shafts. The book is well written and describes many details of the work.

Structural Drawing. By C. Franklin Edminster, Instructor in Department of Fine and Applied Arts, Pratt Institute, Brooklyn, N. Y. Published by the author. Cloth, 9 x 7 ins., 146 pp.; 74 plates; $2.50.

This is a book for self-instruction and class room work in structural drafting and it is, we think, the only one that has been published. Structural drawing alone is considered and practically structural drawing for steel work alone is taken up in detail. The book begins with a short chapter on the selection of drawing materials and instruments and this is followed by chapters on geometrical problems and on simple projection. Structural details are then taken up beginning with sections of steel shapes and their dimensioning, and following with bolts and nuts, turnbuckles and rods, simple connections and so on step by step to the more complex connections and assembled drawings. The book is an excellent one for its purpose.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0510. **Portland Cement.**—Peninsular Portland Cement Co., Jackson, Mich.

This 68 page pamphlet is unusually interesting. A description is given of the plant of the Peninsular Co., which is followed by an analysis of the company's cement. Under the headings of Cement Buildings, Concrete Bridge Construction, Sewers, Concrete Stairways, Street Pavements, etc., there is an interesting running description of structures and methods of using Portland cement. The descriptive matter is illustrated by a number of handsome halftone views, and the pamphlet altogether makes very interesting reading.

No. 0511. **Art Metal Works.**—F. P. Smith Wire & Iron Works, Chicago, Ill.

This catalog contains 128 pages giving illustrations, prices and other catalog information concerning the very large line of ornamental iron work manufactured by the firm. All classes of ornamental work for buildings, fencing, plumbing work, etc., are described.

No. 0512. **Crushing and Grinding Machinery.**—E. H. Stroud & Co., Chicago, Ill.

This company manufactures a complete line of crushing and grinding machinery for all kinds of work. This machinery is illustrated and described in some detail in this 128-page pamphlet. The catalog is unusually good in its descriptive matter. It not only explains the construction and operation of the various machines, but it shows by line drawings the arrangement of complete crushing and grinding plants. Anyone having occasion to use crushing and grinding machinery of any sort, should have this catalog on file.

No. 0513. **Portland Cement.**—Marquette Cement Mfg. Co., Chicago, Ill.

This pamphlet contains 72 pages, the bulk of which are devoted to halftone illustrations of buildings and other structures in which Marquette Portland cement has been used. The text gives a brief history of the manufacture of Portland cement and describes more at length the process of manufacture, at the Marquette Works. There are quite complete instructions for using Portland Cement in general concrete work, in sidewalk work, cellar floors, etc., and in making concrete building blocks. Standard specifications for Portland cement adopted by the American Society for Testing Materials, by the Rock Island R. R., and by the United States government are printed in full.

No. 0514. **Centrifugal Pumps.**—The American Well Works, Aurora, Ill.

This 64 page pamphlet catalog gives dimensions, etc., of both horizontal and vertical centrifugal pumps made by the firm named above. As an introduction to the catalog matter proper, the pamphlet gives the company's guarantee for centrifugal pumps and follows this with a number of data of interest to pump users, and with a complete set of directions for installing centrifugal pumps to get the best results. The pamphlet is well worth securing by anyone interested in the subject.

No. 0515. **Reinforced Concrete.**—Condron & Sinks Co., Chicago, Ill.

This pamphlet contains 31 pages devoted almost entirely to halftone views and line drawings of reinforced concrete and steel structures designed and constructed by the above named company. The catalog is handsomely printed, and a number of the structures shown are of decided interest.

No. 0516. **Concrete Mixers.**—R. Z. Snell Mfg. Co., South Bend, Ind.

This pamphlet describes and illustrates the Snell mechanical mixer for concrete. Both hand and power machines are described. The machine is of novel construction, and the catalog shows clearly the methods of charging, mixing and discharging the batch.

No. 057. **Concrete Block Machines.**—Ideal Concrete Machinery Co., South Bend, Ind.

This pamphlet contains 48 pages of testimonial letters received by the company named regarding the advantages of the Ideal machine for making concrete blocks.

No. 0518. **Industrial Cars.**—The Ohio Ceramic Mfg. Co., Cleveland, Ohio.

This company manufactures a complete line of cars for clay working plants. Standard dump cars are given special consideration. These are made of both steel and wood, and several of the types shown should be of interest to general contractors as well as to brick and tile manufactures.

No. 0519. **Wheelbarrows and Scrapers.**—Lansing Wheelbarrow Co., Lansing, Mich.

This is a 173 page general catalog of carts, trucks, scrapers, wheelbarrows, etc., made by the firm named above. To the general contractor, the portions devoted to wheelbarrows and scrapers will be of interest. These tools are made in various styles and sizes of both wood and steel.

No. 0520. **Carbon Break Circuit Breakers.** General Electric Co., Schenectady, N. Y.

In this bulletin the company describes a number of its well-known lines of circuit breakers. Type C, Form G, circuit breakers are designed for a small, reliable, automatic, protective device for direct and alternating current systems at a moderate price. Type C, Form P are particularly adapted for use on railway and power systems which are frequently subjected to severe short circuits and heavy overload. They are made up to 12,000 ampere capacity. Type C, Form K, especially designed for heavy service, are particularly well suited for railway work. They are made in capacities up to 10,000 amperes. The bulletin also contains descriptions of auxiliary switches, automatic tripping, devices, etc., to be used with the circuit breakers, and gives complete data as to capacities, prices and dimensions of the devices shown. The bulletin contains 36 pages and is conveniently arranged for reference.

No. 0521. **Thomson Horizontal Edgewise Instruments.** General Electric Co., Schenectady, N. Y.

This company manufactures a complete line of horizontal edgewise instruments for switchboard service, including ammeters, voltmeters, single-phase wattmeters, polyphase wattmeters, frequency indicators and power factor indicators. Bulletin No. 4551, recently issued by the company, illustrates and describes the various types, giving dimension sketches and a complete set of full sized scales. The wattmeters, power factor indicators and frequency indicators are constructed on the direct-reading dynamotor principle; the ammeters and voltmeters on the well-known Thomson inclined coil principle. All the instruments are of uniform size, thus giving a pleasing appearance when installed. The horizontal edgewise design has been adopted for the majority of high grade work, since it was first introduced some years ago. While primarily designed for alternating current service, the voltmeters, ammeters and wattmeters can be used with good results on direct current.

C. E.

The civil engineer who aims to succeed when in responsible charge of men should study the system employed by some successful manager. "Field System," by Frank B. Gilbreth, has just been published, after years of private use on Mr. Gilbreth's contract work. Read the advertisement of the book on page 24.

SEND A POSTAL

for catalogs of new books for engineers and contractors. Better do this

TO-DAY

and have them handy for future reference.

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

715 Illustrations; 70 Tables and 906 Pages

Shows the size of Mr. Homer A. Reid's book.

"Concrete and Reinforced Concrete Construction"

Price, $5 net, postpaid

This book contains more text pages, more drawings, more tables of text data, more ORIGINAL matter, than any other book or books ever published on this subject.

WRITE FOR 16-PAGE TABLE OF CONTENTS

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 67[illegible]0
NEW YORK OFFICE: 13-21 Park Row
Telephone [illegible] Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone [illegible]82-4 Main

HALBERT P. GILLETTE . . . Managing Editor
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, } Associate Editors
MYRON C. CLARK . . . . Manager
A. B. GILBERT . . . . Advertising Manager

SUBSCRIPTION RATES (Payable in Advance) - ***$2.00*** *a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*

$2.50 *a year (52 issues) to Dominion of Canada.*

$3.00 *a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Entered as second-class mail matter at the Post Office at Chicago, Ill.

CONTENTS

EDITORIAL:

The Roles of Drainage and Design in Waterproofing Work................29

CONCRETE SECTION:

Proposed Traveling Form for Constructing Water Pipe or Sewers.....30
Method and Cost of Constructing a Concrete Ribbed Arch Bridge.......31

EARTH AND ROCK SECTION:

The Cost of Steam Shovel Excavation and Dredging at Panama...........32
The Quick Unloading of Cars with a Chute 34

GENERAL ARTICLES:

Construction and Operation of Cableways, with Analytical and Graphical Analyses of Stresses...............35

METHODS AND COSTS:

Connecting an Intake Tunnel with Lake Bottom—Ditch Construction in Alaska 39
CATALOGS WORTH HAVING..............40
PERSONALS 40

The Roles of Drainage and Design in Waterproofing Work.

The thought comes upon one at times that the subject of waterproofing is being unduly exploited. It takes but a moment's consideration, however, to show that this thought is not a worthy one. Some natural irritation may be warranted by the persistence with which this fabric, that coating and the other compound are flaunted in the pages of the trade press and even in the publications of the technical societies, but it must not be forgotten that the problem of making concrete structures waterproof is one whose solution is of vital importance. Information of value is scarce and is very largely in the possession of those who make a business of waterproofing. Unbiassed investigations of waterproofing materials and methods have been rare and, we shall be bold enough to say, eminently unpractical in most cases.

Ordinary concrete not only absorbs water but it permits water to penetrate it with astonishing ease. No ordinary thickness of wall, no reasonable precautions in selecting and proportioning materials, no practicable care in placing and ramming gives any certainty against dampness and leakage in concrete work. We make this assertion with full knowledge of the fact that structures have been built of ordinary concrete by the ordinary methods which developed neither leakage nor dampness. The fact that we insist upon is that there is never any certainty of repeating the success. We have knowledge of a concrete standpipe built in a western state without special precautions which according to reports has never leaked a drop. We also have knowledge of another standpipe built under unusually rigid specifications and inspection and by an experienced concrete worker which leaked like a sieve and has cost a great deal of money and labor to make water tight. Only a couple of months ago we described in these columns the building of a small reservoir where one-third of the total expenditure was for stopping leakage.

It is idle, however, to repeat examples. Concrete must be waterproofed to make it tight, and tightness or impermeability is essential in many concrete structures and desirable in all but a few. That a standpipe should not leak is self evident. That a passenger subway, a basement or a tunnel should not be damp and dripping is equally plain. It is better at least that the embedded steel of our reinforced concrete arches and buildings should be kept clear of percolating water. We are pleased to assume that steel embedded in concrete is free from rust. Doubtless we are justified in this assumption. It is overwhelmingly substantiated by tests and has the strong support of chemical theory. Yet there are few concrete engineers who would not feel more easy if they felt sure that water was prevented mechanically as well as by chemical action from getting at the steel reinforcement of a concrete structure.

Concrete must be waterproofed for many uses. Whether it is better to do it by making the concrete impermeable by admixture with or through the absorption of some foreign substance or to do it by giving the porous stone a water-tight integument we shall not consider, but it must be done in some way. In all that is being told and written about waterproofing materials and methods we hear very little of the older subject of drainage. Is our absorption in the study of how to devise waterproofing coatings and compounds making us forget the importance of this older means of handling water? Of course we shall not make a tank hold water by any system of drainage, but we may perhaps prevent a bridge floor or an arch from leaking by such resort. This same possibility is true of many other structures. Even if a good system of drainage will seldom obviate entirely the need of waterproofing it will certainly relieve the waterproofing of much work and thus conduce to its longer life and to its greater efficiency as a water stop. We are not speaking unadvisedly when we assert that there are many concrete bridge floors and arches which are now dripping water despite their waterproofing that would be dry if proper means had been provided for draining away the water that collects on them. Might it not be well if instead of assuming waterproofing to be the sum total of our labors we considered it to be only one component part of a complete system of drainage?

Turning now to one other matter that practice suggests, waterproofing ought not to be reduced to the position of an afterthought in design. Concrete structures have been designed and are still being designed which either make waterproofing impossible or else invalidate the best waterproofing after it is placed. The design of a concrete structure which it is known must be waterproofed should take as much account of this as of any other function that it has to serve. The forces to be withstood by the waterproofing, their points of action, etc., should be determined and provided for as carefully as the loads tending to rupture the wall or arch. The design should also take account of the practicability of doing the work of waterproofing. A designer who detailed a field connection for a steel bridge so that it could not be made because of the impossibility of the men getting at the work to do it properly would be hard put to it to excuse his blunder, yet it is not uncommon to see waterproofing so designed that it cannot be properly placed because the work cannot be got at.

The average cost for supplying 1,000,000 gallons of water, based on the reports of twenty-two cities in 1904, was $92, this sum including operating expenses and interest on bonds.

There are now 551 miles of railway in Ceylon open for traffic. The first section, Colombo to Ambopussa, was opened in 1865. The original cost was $21,340,616, but additional improvements and extension brought the cost up to the end of 1906 to $26,574,986.

The daily average number of steam shovels at work on the Panama Canal during the fiscal year ending June 30, 1906, was 9.17, and for the fiscal year ending June 30, 1907, the daily average number was 29.03. The number of cubic yards excavated per hour, while under steam, by shovels not engaged in preparatory work, averaged 86 for the year ending June 30, 1907.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Proposed Traveling Form for Constructing Water Pipe or Sewers.

A traveling form for constructing a 5¼-ft. diameter water pipe of reinforced concrete was described in our issues of Sept. 11 and 18, 1906. This form was used for constructing several pipe lines for the Salt River, Arizona, irrigation works and as described in the articles referred to did not for various reasons prove satisfactory in respect to the traveling function. The form was designed by Mr. F. Teichman who, as the result of his experience, presents* the following conclusions regarding traveling form construction:

(1.) For a pipe large enough in diameter to allow a man to do the dismantling of the inner mold, no parts of this mold should be pulled along on the inner face of the pipe. In preference, the dismantled parts of the rear should be forwarded to the front, and should be erected rigidly there. The three reasons against a sliding mold are: The continuous or intermittent pulling ahead of the inner mold or parts thereof is likely to disturb the support of the concrete while setting, thus establishing a weakness in the concrete, or a defective union between the reinforcement and the concrete. Parts of the concrete while setting may adhere to the moving mold, thus making a face that is marred, defective in appearance, and in compactness and density of concrete. The movement of the mold is not under easy control as to alignment, and it is impossible to make, at will, angles in the alinement of the pipe without interrupting the continuity of the work.

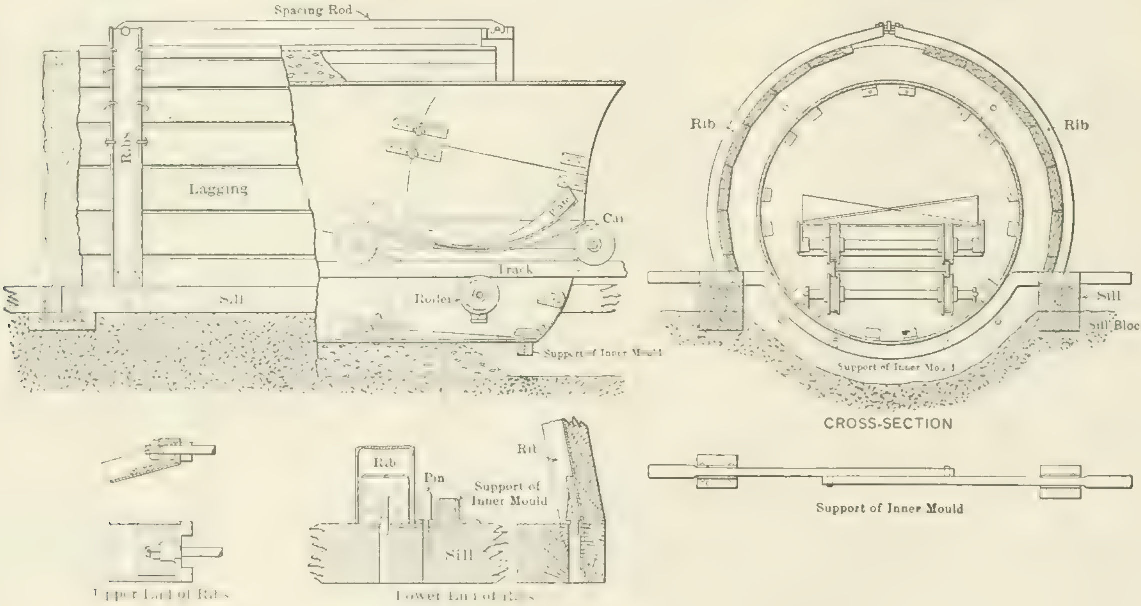


Fig. 1.—Traveling Form for Molding Concrete Pipe.

(2.) The ribs for the lagging of the outer mold should not be suspended from a framework, but should be supported preferably on sills resting on the ground. The support on sills gives greater rigidity to the outer mold than the suspension from a framework.

(3.) The wheeling planks should not be supported by the same structure which supports the mold, otherwise the jars occasioned by the loaded wheelbarrows or cars may be felt in the mold, and this may injure the concrete work.

(4.) The inner and outer molds should be erected on the same base—sills laid on the ground—thus assuring their concentricity. Concentricity makes possible the reduction of the thickness of the pipe to a minimum, and a pipe is cheaper and better, the thinner its walls, provided the reinforcement is properly embedded and the concrete of the wall is strong enough as a beam to support the inner pressure between the two adjoining reinforcement rings.

(5.) Inside the inner mold there should be a track with a car, to carry to the forward end of the mold the plates dismantled at the rear. This track should rest on rollers, placed at intervals near the bottom of the inner mold. A track, thus supported, can be pushed ahead at will so as to be always in a convenient position, for both the rear and front men.

(6.) Instead of arranging the plates of the inner mold in individual courses, square to the axis of the pipe, it is preferable to arrange them in a continuous spiral, in such a manner that their joints, which are square to the spiral, will always be staggered, i. e., strike the plates of the adjoining spiral courses in their middle. For pipe of ordinary diameters, this will give stiffness to the inner mold, even without the use of stiffening angle iron, or brace rods. The spiral plates for a cylindrical pipe mold are as easily made as those for individual courses, but are more easily dismantled and erected than the latter.

(7.) The ribs of the outer mold should be arranged so that the two halves of one rib may be spread more or less at the top as well as at the bottom (with the sills), in order to permit some variation in the thickness of the concrete. The rib halves must be removable before any lagging inside the ribs is removed.

On the basis of these principles, the writer has designed a mold for ordinary pipes of small diameter, as illustrated in Fig. 1. The supports for the inner mold, of course, are in use only ahead of the concrete, and as the concrete approaches them, they are withdrawn (by first spreading the two halves) and moved to the front. While in use, these supports are pinned to the sills just as the ribs of the outer mold are. This secures concentricity of both molds. Any slight change in the direction of the pipe is made by leaving open the spiral joints of the inner mold at one side and covering the gap with light iron pipe or tar paper. At such changes of direction, special sills and lagging, cut to special lengths, are required for the outer mold. The inner track will accommodate itself to slight lateral changes by connecting the different lengths of track by bolts in slotted holes.

---

*"Reinforced Concrete Pipe for Carrying Water Under Pressure. Discussion." Proc. Am. Soc. C. E., October, 1907, pp. 934-937.

The radial dimension of the supports of the inner mold is small enough so that these supports are always inside the longitudinal reinforcing rods, and the length of the arch of these supports is such that the supports may be withdrawn without interfering with these reinforcing rods, if they are spaced in the usual manner.

Method and Cost of Constructing a Concrete Ribbed Arch Bridge at Grand Rapids, Mich.

The bridge consisted of seven parabolic arch ribs of 75 ft. clear space and 14 ft. rise. The five ribs under the 21-ft. roadway were 24 ins. thick, 50 ins. deep at skewbacks and 25 ins. deep at crown; the two ribs under the sidewalks were 12 ins. thick and of the same depth as the main ribs. Each rib carried columns which supported the deck slab. Columns and ribs were bound together across bridge by struts and webs. All structural parts of the bridge were of concrete reinforced by corrugated bars. The abutments were hollow boxes with reinforced concrete shells tied in by buttresses and filled with earth. There were in the bridge including abutments 884 cu. yds. of concrete and 62,000 lbs. of reinforcing metal or about 70 lbs. of reinforcing metal per cu. yd of concrete. Of the 884 cu. yds. of concrete 594 cu. yds. were contained in the abutments and wing walls and 290 cu. yds. in the remainder of the structure.

Centers.—The center for the arch consisted of 4-pile bends spaced about 12 ft. apart in the line of the bridge. The piles were 12x12 in. x24 ft. yellow pine and they were braced together in both directions by 2x10 in. planks. Each bent carried a 3x12 in. plank cup. Maple folding wedges were set on these cups over each pile and on them rested 12x12 in. transverse timbers one directly over each bent. These 12x12 in. transverse timbers carried the back pieces cut to the curve of the arch. The back pieces were 2x12 in. plank, two under each sidewalk rib and four under each main rib of the arch. The back pieces under each rib were X-braced together. The lagging was made continuous under the ribs but only occasional strips were carried across the spaces between ribs. This reduced the amount of lagging required but made working on the center more difficult and resulted in loss of tools from dropping through the openings. Work on the centers and forms was tiresome owing both to the difficulty of moving around on the lagging and to the cramped positions in which the men labored. Carpenters were hard to keep for these reasons.

Concrete.—A 1-7 bank gravel concrete was used for the abutments and a 1-5 bank gravel concrete for the other parts of the bridge. The concrete was mixed in a cubical mixer operated by electric motor and located at one end of the bridge. The mixed concrete was taken to the forms in wheelbarrows. The mixture was of mushy consistency. No mortar piecing was used but the exposed surfaces were given a great work. In freezing weather the gravel and water were heated to a temperature of about 100° F.; when work was stopped at night it was covered with tarred felt and was usually found steaming the next morning.

Cost of Work.—The cost data given here are based on figures furnished to us by Geo. J. Davis, Jr., who designed the bridge and kept the cost records. Mr. Davis states that the unit costs are high, because of the adverse conditions under which the work was performed. The work was done by day labor by the city, the men were all new to this class of work, the weather was cold and there was high water to interfere, and work was begun before plans for the bridge had been completed so that the superintendent could not intelligently plan the work ahead. Cost keeping was begun only after the work was well under way. Many of the items of cost were incomplete in detail.

The following were the wages paid and the prices of the materials used:

Materials and Supplies:	
No. 1 hemlock matched per 1,000 ft.	$20.00
No. 1 hemlock plank per 1,000 ft.	17.00
No. 2 Norway pine flooring per 1,000 ft.	19.00
No. 2 yellow pine flooring per 1,000 ft.	20.00
12x12 in. x 16 ft. yellow pine per 1,000 ft.	29.00
12x12 in. x 24 ft. yellow pine piling per 1,000 ft.	27.00
Maple wedges per pair	.50
½ in. corrugated bars per 100 lb.	2.615
¾ in. corrugated bars per 100 lb.	2.515
⅞ in. corrugated bars per 100 lb.	2.515
Coal per ton	4.00
Electric power per kilowatt	.06
Medusa cement per bbl	1.75
Ætna cement per bbl	1.05
Bank gravel per cu. yd	.85
Sand per cu yd	.66
Carpenters, per day	$3 to 3.50
Common labor, per day	1.75

The summarized cost of the whole work, with such additional costs as the figures given permit of computation, was as follows:

General service:	Total.	Cu. Yd.
Engineering	$151	$0.512
Miscellaneous	$ 75	$0.084

Pumping:	Total 110 days.
Coal at $4 per ton	$210
Machinery, tools and cartage	283
Labor	497
Total	$990

This gives a cost of $9 per day for pumping.

Excavation:	Total Cost.	P. C. Total.
Timber, cartage, etc.	$ 375	17.6
Tools	69	3.3
Labor at $1.75	1,687	79.1
Total	$2,131	100.0

Filling 5,711 cu. yds.:	Total.	Per Cu. Yd.
Earth	$1,142	$0.20
Labor, including riprapping.	396	0.07
Total	$1,538	$0 27

Removing old wing walls:	Total.
Labor and dynamite	$346
Tools and sharpening	64
Total	$410

Hand rail 150 ft.:	Total.	Per Lin. Ft.
Material	$278	$1.85
Labor	29	0.19
Total	$307	$2.04

Wood block pavement, 296 sq. yds.:	Total.	Per Sq. Yd.
Wood block, etc	$695	$2.35
Labor	57	0.19
	$752	$2.54

Steel, 62,000 lbs.:	Total.	Per Lb.
Corrugated bars, freight, etc.	$1,498	2.41c
Plain steel, wire, etc	75	0.12c
Blacksmith'g, tools and placing	438	0.71c
Total	$2,011	3.24c

Centering:	Per Cu. Yd. Total.	Per Cu. Yd. Concrete.
Lumber and poles	$332	$1.14
Labor	272	0.95
Total	$604	$2.09

	Total	Per Cu. Yd.
Forms	$3,312	$3.75
Concrete	$5,532	$6.25
Grand total	$18,113	$20.50

In more detail the cost of the various items of concrete work was as follows for the whole structure, including abutments, wing walls and arch, containing 884 cu. yds.:

Form construction:	Total.	Per Cu. Yd.
Lumber and cartage	$1,547	$1.75
Nails and bolts	129	0.15
Tools	110	0.12
Labor, erecting and remov'g	1,526	1.72
Total	$3,312	$3.74

Concrete construction:

Materials:		
Medusa cement at $1.05	$1,218	$1.37
Ætna cement at $1.75	499	0.56
Sand at 66 cts. per cu. yd.	37	0.04
Gravel at 85 cts. per cu. yd.	915	1.04
Total materials	$2,669	$3.01

Mixing		
Machinery and supplies	$ 549	$0.62
Power at 6 cts. per k. w.	52	0.06
Tools	22	0.02
Labor	737	0.83
Total mixing	$1,360	$1.53
Placing concrete	$ 600	$0.68
Tamping concrete	$ 481	$0.54
Heating concrete:		
Apparatus and cartage	$ 47	$0.05
Fuel	96	0.11
Labor	270	0.31
Total heating	$ 413	$0.47
Grand total	$8,844	$9.98

Considering the abutment and wing wall work, comprising 594 cu. yds., separately, the cost was as follows:

Forms:	Per Cu. Yd.
Materials	$1.20
Labor	1.09
Total	$2.29
Concrete:	
Materials	$2.92
Labor	2.38
Total	$5.30
Heating water and gravel	$0.70
Grand total	$8.29

Considering the arch span, comprising 290 cu. yds., separately, the cost was as follows:

Forms:	Per Cu. Yd.
Materials	$3.70
Labor	3.03
Total	6.73
Concrete:	
Materials	$3.22
Labor	3.57
Total	$6.79
Grand total	$13.52

Advance statistics of the Interstate Commerce Commission for the year ending June 30, 1906, show the steam railroads of the United States had a total of 222,340 miles of first track, with a total trackage of 317,083 miles.

During 1906 there were 557 men killed and 1,212 injured in the anthracite mines and 477 killed and 1,160 injured in the bituminous mines in the state of Pennsylvania. The causes of the fatalities in the anthracite mines were as follow:

Explosions of gas and dust	43
Falls of roof	214
Explosions of powder	28
Other causes inside mines	171
Outside mines	101

In the bituminous regions the fatalities were caused by accidents as follows:

Explosions of gas and dust	10
Falls of roof	305
Explosions of powder	1
Other causes inside mines	139
Outside mines	22

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of Steam Shovel Excavation and Dredging at Panama.

In the report of the Isthmian Canal Commission for the fiscal year ending June 30, 1907, Major D. D. Gaillard, member of the commission, who is in charge of the Department of Excavation and Dredges, gives some details of the work done during the year. Some items of cost have been omitted and others are so listed that the exact cost of all the work cannot be obtained. The following has been compiled from the Major's report and from that of the commission.

The reader must remember that prior to June, 1906, the commission considered that much of the work done with shovels and other excavation work were of a somewhat preparatory nature, consequently the output of the shovels was necessarily less than when working on a regular basis, and the cost of excavation would naturally be high. This stage, having been passed, the year's work just closed gives a clue to what may be expected in the way of economical and rapid excavation in constructing the canal. During the first six months of the past fiscal year an average of 20 steam shovels were at work, while for the last half year the average was a little over 38.

The actual amount of material excavated monthly in the Culebra division during the fiscal year ending June 30, 1907, measured in place was:

Month	Earth	Rock	Total
1906	Cu. yds.	Cu. yds.	Cu. yds.
July	48,272	111,517	159,789
August	53,839	190,984	244,823
September	106,224	185,228	291,452
October	109,003	217,106	327,009
November	72,618	149,024	221,642
December	138,201	169,488	307,689
1907			
January	267,458	299,292	566,750
February	316,461	322,651	639,112
March	434,970	380,300	815,270
April	382,344	497,183	879,527
May	298,756	391,609	690,365
June	213,355	411,231	624,586
Total	2,422,401	3,325,613	5,768,014

It will be seen that about 60 per cent of the excavated material was classed as rock. The haul on the material was from 1 to 15 miles, the average for the year being 10 miles. After taking the loaded cars from the Culebra Cut, they are hauled to two yards, one at White House and the other at Pedro Miguel. At these yards the cars are made up into trains and then hauled to the dumps, the earth and rock being dumped on the same ground.

The classification of the materials as made, is as follows:

Earth includes soil, alluvium—such as clay, sand and gravel—and clays of decomposition, in which all traces of the original structure of the rock from which they are derived have been lost.

Soft rock is easily understood to mean material that is more or less consolidated but still soft enough to be handled with picks or steam shovels.

Hard rock implies that the material is too tough and hard for picks or steam shovels to make any impression on it, and that blasting is in all cases necessary.

The hard rocks encountered in the canal excavation are breccias, tuffs, massive igneous rock, sandstones, conglomerates and limestones. Overlying most of the solid rocks of the region to depths of from 5 to 50 ft., is a red and yellow gritty clay. This clay is the residue of decomposed rock and contains residual fragments or rounded masses of the unaltered rock from which it was derived. In the Culebra Cut a large per cent of this material has been excavated, and the hard rock is now being moved. This rock will no doubt become harder and firmer as the depth of excavation increases.

The shovels used at Panama are of three sizes, namely 45 ton, 70 ton, and 95 ton, with dipper capacity of 1¾, 2½ and 5 cu. yds., respectively. During the year the daily average number of shovels at work was 29.03. At the beginning of the fiscal year 39 steam shovels had been received, but 19 of them were not worked during the first 6 months of the year. Up to the end of the fiscal year, 63 steam shovels had been delivered, erected, and accepted. Thus of an average of 50 steam shovels available during the year, only an average of 29 worked. The average worked, should certainly not have been less than 35, which would have allowed 4 out of the 39 shovels on hand at the beginning of the year, to be laid up for repairs, or for lack of men.

About 66 miles of track were in operation at the beginning of the year, while at the close about 106 miles of track were being used. The first tracks put down in the Culebra division were of old Panama Railroad and Belgian rails, but the new track laid has been done for the most part with 70 lbs. American steel rails. Along the bottom of the canal from Culebra summit to the White House material yard there are four running tracks, and from Culebra summit to the Pedro Miguel material yard there are three running tracks. The report states that these tracks are now in a fairly satisfactory condition, although work has been considerably retarded by the slow arrival of track material, particularly material needed for switches. With shops and rails on the isthmus, it would seem possible and feasible to manufacture some switches. Contractors frequently do this sort of thing, and keep outfits at work that would otherwise be idle.

The steam shovels have loaded the excavated material onto flat cars, of which 1,245 have been used. There were also used 267 12-yd. Western dump cars and 86 20-yd. cars of the same make, beside 198 6-yd. old French dump cars. For unloading the flat cars 28 Lidgerwood plows were used and 18 Lidgerwood unloaders. For spreading the dirt on the dump 12 spreading machines were employed. Some temporary trestles are used on the dumps, but the most of the cars are dumped on the top of embankments and the material spread, after which the tracks are shifted. This track shifting is done by hand and also by machine, there being in use three track throwing machines. Some of the dumps are extremely wet and boggy, especially during the wet season. Heavy rains retard the dumping at East La Boca, as the tracks get in bad shape. At such places it might be well to use more temporary trestles to dump from. With large spreading machines an embankment about 40 ft. wide can be made from a trestle, and if the trestle is 20 ft. or more in height the cost per cubic yard for the timber work would hardly be excessive.

During the year at Culebra 99 ins. of rain fell, the greatest rain fall being in July, 1906, when more than 20 ins. fell. During the month of January, 1907, there was no rain. The monthly average for the year was 8.25 ins. The average of 4 months of the dry season was .15 in. The average of 8 months, excluding the four wet months was 3.98 inches.

The average number of days worked per month during the year was 25.2. The average output for shovel was as follows: Per hour of actual work, 158 cu. yds.; per hour of shovel under steam, 83 cu. yds.; per day, 610 cu. yds.; and per month, 15,467 cu. yds. The majority of these shovels are 70 ton and 95 ton weight.

The largest output of all the shovels was that made by steam shovel No. 218, a 95 ton shovel, which in 260 excavator days took out 211,055 cu. yds. of rock and 42,967 cu. yds. of earth, a total of 254,022 cu. yds. for the year. This gives an average daily output, based on 260 days worked of 977 cu. yds., but on the 303 days possible to have worked it gives a daily output of 838 cu. yds., of which nearly 85 per cent was rock.

The total amount of material actually moved during the year was 3,291,856 cu. yds.

Up to January, 1907, the power drills were all run by steam, but during that month the compressed air plant was put in operation, and since then the drills have been run by air. During the fiscal year 39 well, or mechanical churn, drills, and 139 air drills were used, beside some hand drilling being done. The number of linear feet of holes drilled during the fiscal year, were as follows:

	Lin. ft.		Miles
Steam and air drilling	442,839	or	83.9
Well, or mechanical churn drilling	167,052	or	31.6
Hand drilling	100,101	or	19.0
Total	709,992	or	134.5

The amount of each kind of drilling done per cubic yard of rock blasted was:

Steam and air drilling	0.13 ft.
Churn drilling	0.05 ft.
Hand drilling	0.03 ft.
Total	0.21 ft.

The quantities of explosives used during the year was 1,203.5 tons, being:

	Pounds.
Dynamite	1,998,655
Black powder	408,385

This gives an average for each cubic yard blasted of .73 lbs. of explosives, 84 per cent being dynamite and 16 per cent black powder. One of the largest blasts put off during the year was on the west side of the canal at Bas Obispo. In 4 holes, drilled 78 ft. deep, 9,600 lbs. of black powder displaced 29,640 cu. yds. of rock.

The average number of laborers at work blasting during the year was 768. The air drills are operated by negroes and Spaniards under the direction of American foremen, one foreman being in charge of 6 to 8 drills. Drill runners are paid from $75 to $150 in gold per month, the majority of them receiving $125 and $150 per month. Helpers are paid $75 per month. Powder men are paid from $100 to $150 per month. The total cost per cu. yd. for blasting rock was 25.57 cts.

The laborers on the Culebra division are Spaniards, Italians, West Indian negroes and a few negroes from the United States. The length of the day worked is 8 hrs. Spaniards and Italians are paid 20 cts. per hr., and the best Indian negroes are paid 10 cts. an hour.

The following wages are paid per month to men listed:

Steam shovel engineers	$210
Cranemen	185
Firemen	83
Locomotive engineers	210
Conductors	190
Yard masters	210
Unloader engineer	125
Track throwing engineer	125
Pile driving engineer	125
Pumpmen	50 to 135
Foremen	100 to 175

In making out the average cost of the excavation per cubic yard by steam shovels, a charge entitled "Arbitrary, to cover cost of plant," has been added to the cost of excavation. This fixed charge has been added to the cost of every cubic yard of material excavated, so that by the time the canal is completed, a total sum will have been charged equivalent to the original cost of the plant. This charge must not be confused with repairs and depreciation of the plant, for the repairs are included in the cost of operation, and if the plant is properly maintained a great part of it will have some value at the end of the job, consequently this charge is not depreciation.

The different items which go to make up this arbitrary charge per cubic yard of material excavated are as follows:

Steam shovels	$0.0075	Includes cost of new shovels set up ready for service.
Cars	0.0450	Cost of new cars.
Engines	0.0250	Cost of new engines and rebuilding French engines.
New appliances	0.0100	Cost of new appliances, as unloaders, unloading plows, spreaders.
Track material	0.0175	Cost of new track material.
Structures	0.0025	Cost of structures, as coal pockets, roundhouses, magazines, yard offices, etc.
Miscellaneous	0.0025	Cost of drills, channelers, pile drivers, etc.
Contingencies	0.0100	Miscellaneous expenditures covering investment of plant.
Total	$0.1200	

Under the cost of plant the total amount charged to June 30, 1907, was as follows:

Steam shovels	$ 576,858.16
Cars	2,145,792.00
Engines	2,088,633 17
New appliances	176,083.79
Track material	679,184.28
Structures	14,207.59
Miscellaneous equipment	83,109 59
Contingencies	8,500.41
	$5,772,368 99

Nearly all the large items of plant needed for the Culebra division have been already purchased and are in operation, with the exception of about 300 Lidgerwood flat cars and about 500 dump cars. Thus, if we assume that the output of five and three quarter million of yards of excavation will not be exceeded, the 12 cts. charge for plant will pay for the entire cost of the plant necessary in from 8 to 9 years.

During the year 79,500 tons of coal, costing $515,453, were used on the Culebra division. This is at a cost of $6.48 per ton. Could this coal have been purchased for

$3.25 per ton, it would have reduced the cost on all the excavation in the Culebra by 4½ cts. per cu. yd.

The cost per cubic yard for excavating earth during the year has been as follows:

Excavation by steam shovels	$0.1081
Transportation	0.1942
Tracks	0.0830
Dumps	0.1548
General expense	0.0193
Total	$0.5594
Arbitrary to cover cost of plant	0.1200
Grand Total	$0.6794

To obtain the cost of excavating rock the charge of 25.57 cts. for blasting must be added to the above, making a total of 93.51 cts.

The average number of common laborers employed for each steam shovel worked, during the year, for the various purposes listed was as follows:

Blasting per steam shovel	26 men
Around steam shovel	13 men
Track work per steam shovel	22 men
Dumping per steam shovel	47 men
Transportation per steam shovel	9 men
Water service per steam shovel	3 men
Total per steam shovel	120 men

This is an extremely large number of men to be working on a single steam shovel outfit running one shift, and goes far to explain the high cost of the many items of the work.

The cost per cubic yard as given does not include the material used in the repair of locomotives, steam shovels, and cars, nor does it include the cost of operating the air compressor nor the proportionate cost of administration and general expenses of the mechanical department, which makes repairs on plant for the Culebra division. In the future these items are to be charged against the excavation work. This will increase the cost.

DREDGING.

The dredging during the past year has been done in the Colon and La Boca divisions. The greater portion of the work has not been in the canal prism, but in accessory work that is necessary for the rapid completion of the canal, and to allow of the handling of materials for the canal and the plant.

In the Colon division three machines have been at work. An old French ladder dredge, one 5 yd. dipper dredge, built by the Atlantic, Gulf & Pacific Co. of New York, and one 16 in. suction dredge. The suction dredge discharged the dredged material on the bank filling in land adjoining to the ditch, while the other dredges loaded the material into self propelling dump barges used by the French and known as clapets. In this district 1,112,321 cu. yds. was dredged during the fiscal year, of which 43,602 cu. yds. was rock, mostly coral. No cost of this dredging is given in the report.

The dredging in the La Boca division was done by two machines. A 5 yd. dipper dredge worked 22 days, in which time it excavated 22,300 cu. yds. The second machine, an old French ladder dredge, was operated both day and night.

In all 5,832 hours during the year was spent in actual dredging; 501 hours undergoing repairs due to break downs; 966 hours in placing plant, changing crews and other delays chargeable to dredging operations: 168 hours' delay was caused by passing ships, storms, and delays not chargeable to operation, and 1,293 hours due to Sundays and holidays.

A total of 1,213,597 cu. yds. of soft material, place measurement, was removed by this dredge during the year. The total cost of repairs, supplies, and wages of crews amounted to $125,463.95, making the cost per cu. yd. of material removed for operation of dredge about 10 1-3 cts. The coal for the dredges delivered on board, cost $7.50 per ton. As will be seen the costs given of dredging is very meagre.

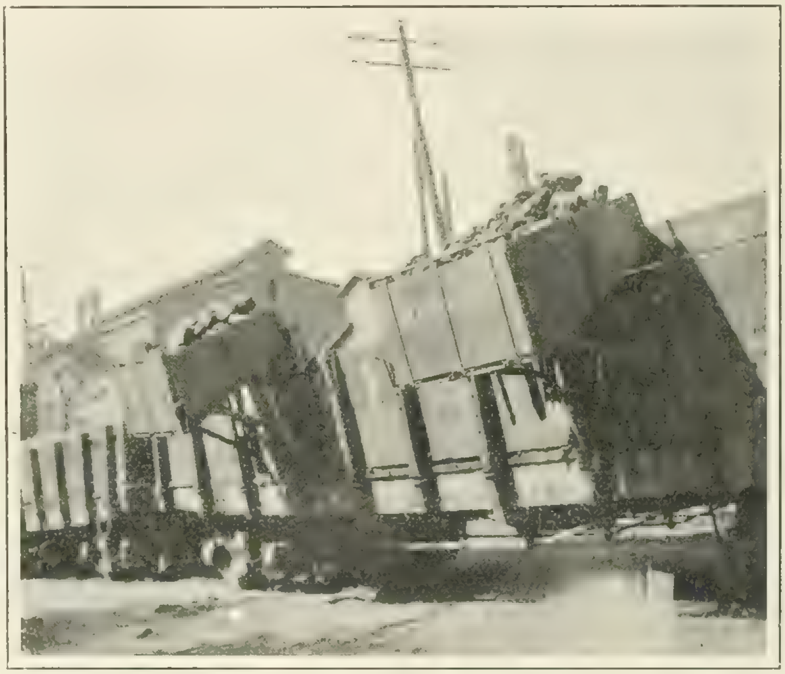
This work is still in the preparatory stage. New dredges are being built and delivered to the canal commissioners, and old dredges are being repaired and rebuilt. The marine shops have been fixed up and equipped for work and during the year 1907 and 1908 a much larger amount of dredging work will no doubt be done.

The Quick Unloading of Cars With a Chute.

Most crushed stone and sand are shipped in flat bottom cars, and as these materials have to be hauled from the railroads in wagons much time is lost by the teams in waiting to be loaded. This lost team time is easily estimated, but the money lost in this manner is frequently ignored.

If four wagons are needed to make a given haul, in order to keep the crew busy, that is, unloading the cars, it is evident that the four wagons lose in the aggregate 10 hours waiting to be loaded, or 2½ hours per day for each wagon. When teams are worth $5 per day this means a money loss for each wagon of $1.25 per day.

From this it is readily seen that any contrivance that will cut out this lost team time is bound to save money. We illustrate herewith the quick unloading car chute, that has been built for this very purpose, and has already been used for some time in the south. The chute is attached to the side of the car, and is loaded by the unloading crew. When a wagon comes to the car to be loaded it drives under the chute, the catch is knocked up and the wagon is loaded in less than a minute, so those who have used it claim.



Quick Unloading Car Chute.

This allows of the number of wagons to make a certain haul, being reduced, while the cost of the chute is nominal. The chutes are in three sizes, the medium size holding one cubic yard, selling for $60. Special sizes are made to order.

With this chute and patent dump wagons the time for both loading and unloading wagons is nil; hardly enough to give the horses time to spell themselves. The chute is built so it can be adapted for use on any size or style of car. A little time must be taken to adjust it to each car, but when once adjusted, it is stated that it works easily and well.

This chute is manufactured and sold by the Quick Unloading Car Chute Co., 8 Watts Building, Birmingham, Ala.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Construction and Operation of Cableways with Analytical and Graphical Analyses of Stresses.*

BY F. T. RUBIDGE.†

Definition.—A cableway is a hoisting and conveying system, consisting of a single span of cable upon which is mounted a carriage with the necessary sheaves, ropes and power to hoist a load from any point and convey it to any other point beneath the cable. The motive power may be installed upon the carriage itself or transmitted from an engine at either end of the span.

A horizontal cableway is one in which the ends of the span may be on the same or different levels. It is, therefore, of general application.

An incline cableway is one in which, by reason of a sufficient inclination of the cable, the power required to hoist the load is less than that required for conveying. This enables the use of a single rope for both hoisting and conveying.

HORIZONTAL CABLEWAYS.

In this system it is obvious that, in addition to the cable and the carriage which travels upon it, there must be provided independent means for hoisting and conveying the load.

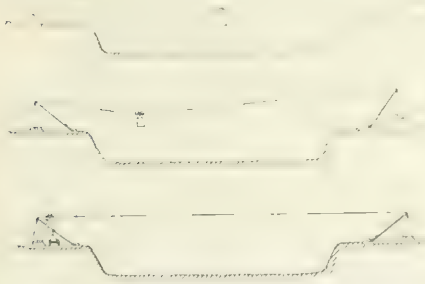


Fig. 1.—Balanced Cable Crane Horizontal Cableway.

In the case where the motor is installed upon the carriage the latter is propelled by gearing to the sheaves traveling upon the main cable, causing them to act as drivers. The path which the carriage travels when both ends of the main cable are fixed is approximately an ellipse. It is apparent that under such conditions the inclination near the ends of the span is such that it would be impossible to drive the carriage beyond a certain point, owing to slipping of the driving sheaves. The difficulty is overcome by putting the main cable under a constant tension, causing the carriage to travel approximately along a uniform grade. This may be accomplished by having one end of the main cable fixed, while to the other end, after the cable passes over a sheave, a weight is attached. The disadvantage of this simple device would be the continual bending of the main cable passing over the sheave, while under stress. To bring this bending strain within safe limits would require a sheave so large that its use would be impracticable. The difficulty is overcome by the use of bents, free to move at the top in the direction of the cable. Figure 1 illustrates the system. It has the trade name of "the Balanced Cable Crane." The electric motor is the most practicable for this system, though it necessitates the paralleling of the main cable with a trolley wire. The fact that the cable must sustain the additional weight of the motor and motorman is a disadvantage, but in many cases it is probably offset by the decided advantage of having the operator close to the loading and unloading, thus minimizing danger and delay.

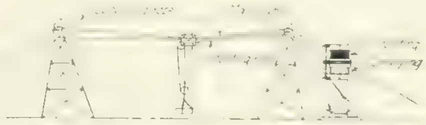


Fig. 2.—Arrangement of Lidgerwood Cableway.

In cases where the engine or motor is located at the end of the span, at least two ropes in addition to the main cable are necessary—the one for hoisting and the other for conveying. When the orange peel, clam shell or other self filling bucket is employed, a third rope and an extra drum on the engine must be provided.

Arrangement of Hoisting and Conveying Ropes.—Figs. 2, 3 and 4 show three different arrangements of hoisting and conveying ropes which have been adopted by the Lidgerwood Manufacturing Co., the Lambert Hoisting Engine Co. and the Trenton Iron Co. respectively.

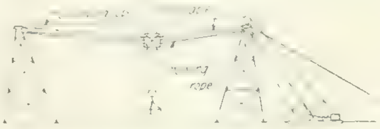


Fig. 3.—Arrangement of Lambert Cableway.

In the arrangement shown in Fig. 2 the load is first hoisted to the desired height. During conveying, both the hoisting and conveying drums must be in operation, and of the same diameter, so that the load may remain at a constant distance from the cable.

In the arrangement shown in Fig. 3 the engine drums usually have different diameters, the larger being the conveying drum. This arrangement permits simultaneous hoisting and conveying, and a conveying speed greater than hoisting speed. A somewhat larger engine is necessary owing to the two-part hoist, instead of three-part, as in the other arrangement.

The arrangement in Fig. 4 was devised to obviate the necessity of using carriers to prevent sagging of hoisting rope. The hoisting rope is attached to an endless rope at the point *A* by means of a specially constructed swivel connection. The endless rope is passed a number of times around an elliptic-faced drum to give sufficient friction for hoisting the load. In operation both hoisting and conveying drums are in motion during conveying, as in Fig. 4, and both must be of the same diameter.

Fall-rope Carriers.—The econimical operation of a cableway depends in no small measure upon the carriers employed. Their function is to prevent excessive tension (due to sag) in the hoisting rope, so that when the load is detached from the fall-block the latter, while free, will not ascend to the carriage. Even with the use of carriers it is necessary to use a weighted fall-block, so that it may be raised or lowered by the engineer when no load is attached.

The following are styles of carriers which are in use:

(1) *Chain-connected Carriers.*—These consist of a supporting sheave which travels upon the main cable, below which in the same frame are sheaves for the support of other necessary ropes. The side plates which form the frame for the sheaves must project beyond them, so that when adjacent carriers strike each other the sheaves will not come into contact. The connected carriers are attached at one end to the tower and at the other to the carriage. When the carriage is close to the head tower (engine end), the carriers are all in contact with the chains hanging in loops below. As the carriage moves toward the tail tower the carriers are spaced along the cable with the chains hanging in festoons below.

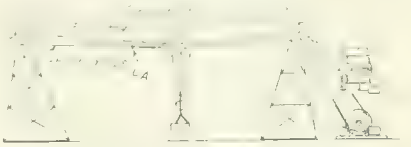


Fig. 4.—Arrangement of Trenton Iron Co. Cableway.

(2) *Button-rope Carriers.*—With this carrier an additional rope across the span is required. It is fixed at one end and kept at a constant tension by a weight at the other. At intervals along the rope are affixed "buttons" with a gradation of diameters, the smallest being the first from the head tower. The carriers are provided with eyes having a corresponding gradation of diameters, slightly smaller than the

---

*Condensed from an article in "The University of Colorado Journal of Engineering" No. 3, 1906-7, published by the Associated Engineering Societies of the University of Colorado, Boulder, Colo.

†Asst. Supt. of Mines, The New Jersey Zinc Co., Franklin Furnace, N. J.

buttons, through which the button rope is threaded. The carriage is provided with a projecting arm or "horn," which picks up the carriers as each is met during the travel of carriage toward the head tower. All the carriers are riding upon the arm when the head tower is reached. On moving away from the head tower, the first button passes through the eyes of all the carriers but the last. This one is snatched from the arm and deposited upon the cable. The second button selects the next carrier, and so on.

(3) *The Lambert-Delaney Carrier.*—This is rather an ingenious device, depending upon the fact that points along the vertical diameter of a horizontally rolling wheel travel at different velocities. The rolling wheel in the case of the carrier is inverted, and rolls upon the under side of the main cable. The conveying rope is the rolling force, and is applied at different distances from the center of the rolling sheave to obtain the required variation in velocity of travel. Fig. 5 illustrates the construction. It will be noticed that in the quarter speed carrier a yoke with set screw is used to increase the friction between the rolling sheave and cable.

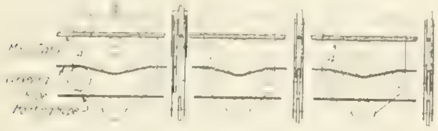


Fig. 5.—Lambert-Delaney Carrier.

The advantages and disadvantages of the above types of carriers are as follows:

Chain-connected Carriers.—Advantages: (a) Simplicity. (b) Not easily deranged. (c) Positive spacing. Disadvantages: (a) Extremely heavy. (b) Considerable wear. (c) Power required to stretch chains as carriage nears tail tower.

Button-rope Carriers.—Advantages: (a) Extremely light. (b) minimum wear to both carrier and cable. (c) Positive spacing. Disadvantages: (a) Maintenance of button rope.

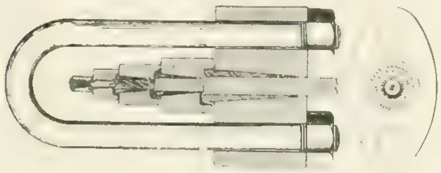


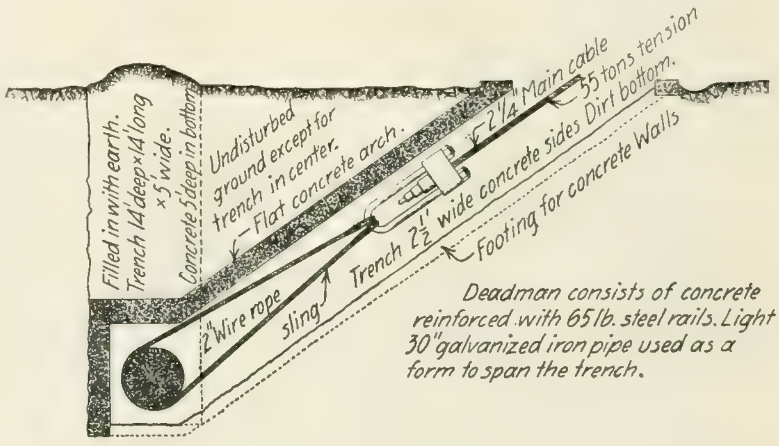
Fig. 6—Step Socket for Main Cable.

Lambert-Delaney Carriers.—Advantages: (a) Neither rope nor chains required for spacing. (b) Weight of carriers uniformly distributed at all times between carriage and towers. (c) Moderate weight. Disadvantages: (a) Double bending of conveying rope while passing through carriers, causing short life of rope. (b) Variable spacing due to slip between rolling sheaves and cable. (c) Large number of sheaves to maintain.

The arrangement shown in Fig. 4 is "the Laurent-Cherry" system, which employs no carriers, as above mentioned. The advantages are: (a) A minimum of working parts not easily accessible. (b) A minimum of dead weight to be sustained by cable. The disadvantages are: (a) The endless hoisting rope is subject to considerable wear owing to constant slipping on elliptic-faced drum. (b) When hoisting from a considerable depth below the main cable and conveying toward the tail tower there is a limit to the distance of approach to the tail tower, owing to the fact that connecion at *A*, Fig. 4, cannot pass over the tail tower sheave. On this account a greater span is necessary under such conditions than in the other arrangements.

Relation Between Size of Engine and Inclination of Cable.—As previously stated, the path which the carriage travels when both ends of the cable are fixed is approximately an ellipse (catenary between carriage and towers neglected). When it is necessary, therefore, to convey the load close to either end of the span, the inclination must be taken into consideration.

In the Lidgerwood and Laurent-Cherry systems, where the diameters of hoisting and conveying drums must be the same, the size of the engine is determined by the load to be hoisted, provided the inclination of the cable does not exceed 22° (19½° with friction neglected). Beyond this inclination the power required for conveying is greater than that for hoisting, and is proportional to the sine of the angle of inclination.


Filled in with earth.
Trench 14' deep × 14' long × 5' wide.
Concrete 5' deep in bottom
Undisturbed ground except for trench in center.
Flat concrete arch.
2¼" Main cable
55 tons tension
Trench 2½' wide concrete sides Dirt bottom.
Footing for concrete Walls
2" Wire rope
sling

Deadman consists of concrete reinforced with 65 lb. steel rails. Light 30" galvanized iron pipe used as a form to span the trench.

Fig. 7.—Concrete Anchorage for Main Cable.

In the Lambert system, where a two-part line is used for hoisting, and where there may be any desirable ratio between the diameters of conveying and hoisting drums, the inclination of the cable at which equal power is required for hoisting and conveying is about 32° (30° neglecting friction). With inclination less than 32° the conveying drum may be larger than the hoisting drum, and for a cableway which is nearly horizontal the engine is provided with a conveying drum about twice the diameter of the hoisting drum. In all cases the ratio of gearing is the same for both drums.

THE INCLINE CABLEWAY.

It is obvious that when the inclination of the cable is such that greater power is required for conveying than for hoisting, the carriage will remain stationary on the cable while the load is being hoisted, even though no conveying or endless rope is used. Should the load be hoisted until the fall-block comes into contact with the carriage, the further pull on the hoisting rope will cause the carriage with the load to move along the cable. A single drum engine is, therefore, all that is necessary.

The simplest form of incline cableway is used where the loading is always done at the same point, also the unloading. In this case a stopping block is clamped to the main cable to prevent the carriage running below the point of loading, and a self-engaging latch is clamped to the cable at the unloading point to hold the carriage in position while the load is being lowered for unloading.

Where it is necessary to provide means for loading and unloading at any point, an endless rope is used as in the horizontal cableway, but no power is necessary for its operation, its function being merely to hold the carriage at any desired point. This is accomplished by passing the endless rope a number of times around an elliptic-faced drum provided with brake only.

The Aerial Dump.—The scope of the cableway is largely increased by the possibility of dumping the contents of the skip at any point in its travel by the manipulation of a lever at the engine. The skip employed has an open end, so that tilting is all that is necessary for dumping. The skip is suspended from the hook of the fall-block by chains with hook ends attached to the sides and ends of the skip. The end of the skip is also attached to another fall-block reeved with the dump line. The latter necessitates two additional sheaves below the cable in the carriage and is reeved in a manner similar to the hoisting rope. In the Lidgerwood self-dumping device the dump line is wound on the hoisting drum, and when it is desired to dump the skip, the line is shifted by a suitable mechanism upon an increased diameter of drum, which is provided for the purpose. This causes the dump line to be drawn in at a higher rate of speed than the hoisting rope, and results in the tilting of the skip for discharging the contents.

In the Lambert system the dump line is attached to its own drum mounted on a shaft with hoisting drum, in close contact with the latter and so arranged that the hoisting drum, when released with a load, can make only a half revolution while the dump line drum is stationary. During hoisting, the hoisting drum drives the dump line drum and, both being of the same diameter, the skip remains horizontal. When it is desired to dump the skip, the brake is applied to the dump line drum and released on the hoisting drum.

The Lambert company has also installed a dumping arrangement for dumping the load close to the towers. It consists of a long hook suspended from a third main cable sheave on the carriage. Owing to the difference in inclination of the cable at the center and ends of the span, the hook, which always hangs vertically, is closer to the skip at the desired end than at other points along the cable. On lowering at the dumping point, the hook engages the bail at the end of the skip. The practicability of this arrangement is doubtful when it is desired to dump the load at the tail tower end. The skip swings more or less when the carriage is stopped, and the engineer, being unable to observe the oscillations, is likely to lower the skip when it is swung away from the hook.

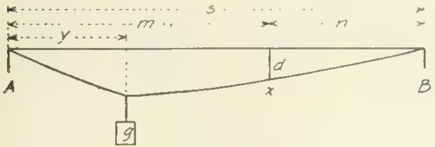


Fig. 8.

Lubrication.—The fact that the sheaves in the carriers, carriage, and tops of towers are not easily accessible renders self-lubricating bushings desirable, and they are generally used. Their use, however, does not mean that little attention is required. The carriage and hoisting rope especially should be carefully examined daily, for, while the apparatus is seldom used to transport men, the load is generally conveyed above them.

Towers.—Either tower may be fixed or movable. When both are movable the tracks must either be parallel or lie in the same circle. The parallel track arrangement was used extensively in the excavating of the Chicago drainage canal. Movable towers diametrically opposite on circular tracks have never been used so far as the writer is aware. A common arrangement, however, is the radial cableway, where one tower is fixed and the other movable.

Movable towers are mounted on standard railroad wheels. The track consists of six or seven lines of rails, and rail braces should be used plentifully. Power for moving the tower may be obtained from the winch-head on the cableway engine, or, if the tower must be moved often, a special engine is provided. Movement is accomplished by block and tackle between the engine and anchorage at either end of the track. Considerable power is necessary on account of the large amount of friction between flanges of wheels and rails.

For low towers in fixed positions the "A" frame is commonly used, but the head tower should not be so low, or the engine so close to it, that the fleet angle of the ropes becomes excessive. In some cases, especially in incline cableways, the tail tower may be dispensed with and a rock anchorage substituted. High towers are common where height is desired for disposal of material beneath the cable, and in very low spans where the deflection of the cable is necessarily large. They are usually constructed of wood, for the reason that the cost is less and in most cases they will last as long as the cableway is required. The base of the tower is usually from one-third to one-half the height. Steel masts are sometimes used for tail towers. They require at least three strong and well anchored guy lines. The base has a ball and socket joint of steel castings, and the customary wood saddle is bolted to the top for the main cable.

Main Cable.—The essential features of the main cable are strength, lightness, flexibility, and a surface which will not only receive the least wear but impart the least wear to the sheaves rolling upon it. The standard hoisting rope is objectionable from the standpoint last mentioned. Though less flexible than the hoisting rope, the locked-wire rope is generally used for the reason that the other qualities are possessed to a much greater degree.

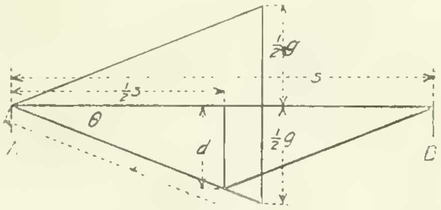


Fig. 9.

Fig. 6 shows the socket used on the locked-wire rope. There are six wedge segments in each cone, with the exception of the smallest, which contains four.

Means are provided for taking up the main cable when the deflection has become excessive, due to stretching. In short spans a turnbuckle is inserted in the sling which passes around the anchorage and thence through a sheave attached to the end of the cable. For long spans, special double or triple sheave blocks are used, reeved with wire rope. The take-up is usually located at the head tower end so that the engine may be utilized when taking up is necessary.

Anchorages.—The tension of the main cable is usually from five to six times the load, depending upon the deflection. Anchorages secure beyond all possible doubt, are essential, as their failure would prove disastrous to the cableway and imperil the lives of men. Since it is impossible to calculate the resistance offered by the earth to a buried anchorage, it is usual to find a much stronger anchorage than is necessary. The usual form for moderate tensions—say up to 30 tons—is a well tarred oak log about 18 ins. in diameter and 16 ft. long, buried to a depth of 8 or 10 ft. If longer life is desired, or if the tension is greater, a concrete anchorage may be substituted. A form which has been successfully used is shown in Fig. 7.

Formulas.—The following are the formulas generally used when the cable is approximately horizontal:

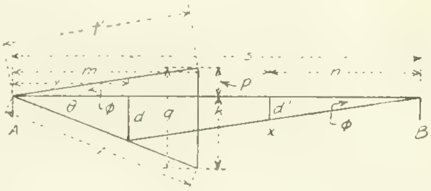


Fig. 10.

In Fig. 8 let w = weight of cable per foot,

t = tension in pounds at tower,

d = deflection of cable in feet at any point, x, distant n feet from tower B and m feet from tower A,

s = length of span = $m + n$,

g = weight of carriage, skip, and load (or concentrated load) in pounds, distant y from tower A.

Deflection at x due to cable alone

$$d = \frac{m\,n\,w}{2\,t} \quad \text{(1)}$$

Deflection at center due to cable alone

$$d = \frac{w\,s^2}{8\,t} \quad \text{(2)}$$

Deflection at x due to concentrated load alone

$$d = \frac{g\,n\,y}{t\,s} \quad \text{(3)}$$

Deflection at center of span due to load alone

$$d = \frac{g\,y}{2\,t} \quad \text{(4)}$$

If $y = s/2$ equations (3) and (4) become respectively

$$d = \frac{g\,n}{2\,t} \quad \text{(3')}$$

and $$d = \frac{g\,s}{4\,t} \quad \text{(4')}$$

Deflection due to both cable and concentrated load is obtained by adding the separate deflections. Therefore for total deflection at x

$$d = \frac{wmns + 2\,gny}{2\,t\,s} \quad \text{(5)}$$

Or at center of span

$$d = \frac{ws^2 + 4\,g\,y}{8\,t} \quad \text{(6)}$$

If $y = s/2$ (5) becomes

$$d = \frac{wmn + gn}{2t} \quad \text{(5')}$$

and (6), $$d = \frac{w\,s^2 + 2\,gs}{8\,t} \quad \text{(6')}$$

If $y = m$ (5) becomes

$$d = \frac{wmns + 2\,gmn}{2\,ts} \quad \ldots\ldots\ldots (5'')$$

and (6) becomes

$$d = \frac{ws^2 + 4\,gm}{8\,t} \quad \ldots\ldots\ldots\ldots (6'')$$

Fig. 9 shows a graphical solution for a concentrated load in the center of the span. We may note the following:

$$\text{Tan } \theta = \frac{2\,d}{s}$$

$$\text{Sin } \theta = \frac{g}{2\,t}$$

Since for small angles (figure is exaggerated), the tangent and sine are nearly equal,

$$\frac{2\,d}{s} = \frac{g}{2\,t}$$

or

$$d = \frac{gs}{4\,t} \text{ which is equation } (4').$$

Substituting $ws/2$ for g,

$$d = \frac{ws^2}{8\,t} \text{ which is equation } (2).$$

We see, therefore, that instead of a uniform load of the rope in the catenary curve it may be assumed as a concentrated load equal to one-half the uniform load.

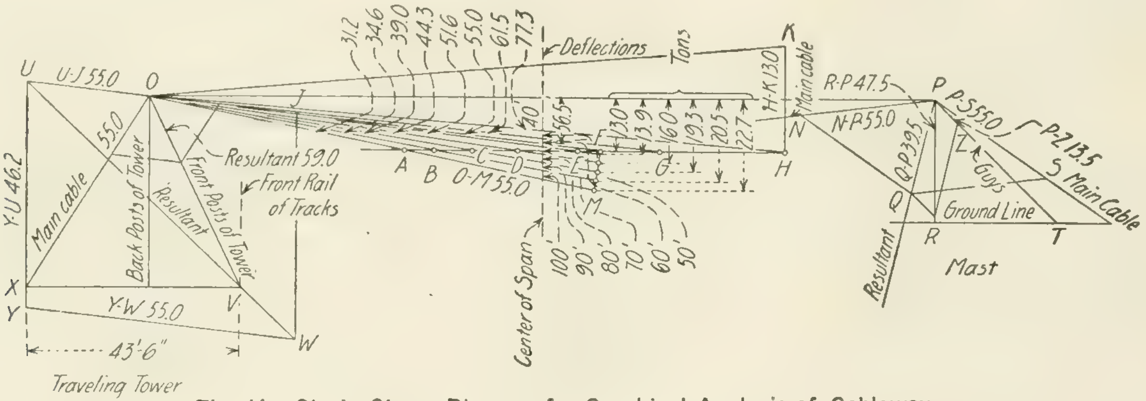


Fig. 11.—Strain Stress Diagram for Graphical Analysis of Cableway.

Fig. 10 shows a graphical solution for the load at any point distant y from tower A. We may note the following:

$$\text{Tan } \theta = \frac{a}{y}$$

$$\text{Sin } \theta = \frac{k}{t}$$

$$\text{Therefore } \frac{d}{y} = \frac{k}{t} \text{ approximately.}$$

$$\text{or } k = \frac{dt}{y}$$

$$\text{Tan } \phi = \frac{d}{s-y}$$

$$\text{Sin } \phi = \frac{p}{t'} \textit{ or } \frac{p}{t} \text{ nearly.}$$

$$\text{Therefore } \frac{d}{s-y} = \frac{p}{t}$$

$$\textit{or } p = \frac{d\,t}{s-y}$$

$$\text{and } k + p = g = \frac{d\,t}{y} + \frac{d\,t}{s-y}$$

$$\text{or} \quad gy\,(s-y) = dt\,(y+s-y)$$

$$\text{or} \quad d = \frac{g\,y\,(s-y)}{ts}$$

Since $d:d' = (s-y):n$

$$d' = \frac{d\,n}{s-y}$$

$$\text{or} \quad d' = \frac{gy(s-y)n}{ts(s-y)} = \frac{gyn}{ts}$$

which is equation (3).

Substituting $ws/2$ for g and m for y, which are the conditions obtaining when deflection at any point due to hope alone is considered,

$$d' = \frac{mnw}{2t} \text{ which is equation (1).}$$

It has been shown that the formulas given above involve the assumption that the tangent and sine of small angles are equal. In the graphical analysis this is unnecessary. It is obvious, therefore, that a graphical solution drawn carefully to a fairly large scale will give closer results than are obtainable from the formulas.

Fig. 11 is a graphical analysis of stresses in the cable and towers of a 953-ft. cableway. It is desired to hoist and convey a load of 10 tons (including skip, fall-block and carriage). Using formula (6′) and assuming a 2-in. locked-wire rope ($w = 10$ lbs.) with a deflection of 50 ft. (about 5 per cent. of span) we find a tension of 58 tons. Since the working load of the 2-in. locked-wire rope is only 43 tons we now see that at least a 2¼-in. locked-wire rope with a working load of 55 tons should be used. The weight of the 2¼-in. rope is 12½ lbs. to the foot or about 6 tons for the 953-ft. span. In the graphical solution, we therefore assume a center concentrated load of 10 + 6/2 or 13 tons. Triangle *OHK* is the force polygon for a deflection of 40 ft. at the center, which gives a tension of 77.3 tons. Tensions for various deflections from 40 ft. up to 100 ft. with 10 ft. intervals are shown to range from 77.3 to 31.2 tons. A line drawn from *O* intersecting the 13-ton line *AFH* so that *OF* is 55 tons, the proper working tension, indicates a proper working deflection at the center of 56.5 ft.

Should it be found necessary at any time to subject the cableway to a load greater than given above, the proper deflection to correspond with the allowable tension of 55 tons is found by drawing an arc with center at *O* and radius *OF* (55 tons) to intersect *OA*, *OB*, etc., produced; scaling the distance between the respective intersections and the line *OP*, and multiplying by 2 will give the respective safe loads (the distance scaled in each case is only one-half the side of an incomplete force polygon). Care must be taken, however, that the hoisting and conveying ropes are sufficiently strong for the increased load.

Comparison of Analytical and Graphical Solutions.—Solving formula (6′) for a deflection of 50 ft., the tension is found to be 61.27 tons; graphical method gives 61.5 tons.

The main advantage of the graphical method is that a glance at the diagram will show the proper deflection for any load. *OXV* represents a traveling tower at one end of the span. The cable is fastened to the tower at *X*, and *V* is the point about which the tower tends to rotate, due to the tension of cable. The polygon *UJWY* shows that a force *Y-U* of 46.2 tons applied vertically at *X* is necessary to obtain equilibrium of the tower. The moment of this force about *V* is 46.2 × 43.5 = 2,009.7 foot-tons, and counter-moments of an equal amount must be applied in the shape of ballast, engine, boiler, or other form. The weight of cableway and tower supplies the safety factor.

The front posts of the traveling tower lie in the line of the resultant of the main cable. They should have sufficient strength to sustain the resultant force of 59 tons. Although the back posts in reality sustain a part of this force, it is well to assume that they take only the vertical load of one-half the cable and the other ropes, plus loaded skips. They are usually of the same size as the front posts.

A steel mast is used for a tail tower and the polygon *NPQ* shows a main cable resultant force of 39.5 tons. The polygon *PRZ* shows that the mast must sustain a load of 47.5 tons, while the guy line *PT* must have a tension of 13.5 tons. Only one guy line is shown but there are four, two extending behind with an included angle of about 60° and two in front with an included angle of about 120°. The front guys are intended to take the side pull when the traveling tower is not in line with mast and anchorage at the mast end. They have not been shown on diagram owing to complexity which would arise were resolutions of forces in a horizontal plane added.

Methods and Costs; Some Old; Some New.

Connecting an Intake Tunnel with Lake Bottom.—The water supply of a small city is obtained through an intake tunnel, about 1,000 ft. long, driven under the lake bottom and connected with the lake through a submerged crib. The method of making this connection is described herewith. After the tunnel had been driven to the desired length, it was found that there was 20 ft. of rock between its top and the bottom of the lake; the depth of water at this point was about 25 ft. A raise of 10 ft. in diameter was made to a height of 8 ft., and a hole drilled in the center of it through to the lake bottom, and a drill pushed through the hole and left projecting several feet above the lake bottom to serve as a guide for the diver. The hole was then plugged with wood. The lake bottom was composed of a layer of sandstone about 1 ft. thick, covered with boulders, and underneath was a bed of young conglomerate, about 8 ft. thick, composed of pebbles several inches in diameter bound together with sand and carbonate of lime. Underneath this conglomerate was a layer of solid sandstone about 3 ft. thick. A dredge with a clam-shell bucket was first used to remove the boulders, and also to remove the first layer of sandstone after it had been loosened by charges of dynamite placed by the diver. An orange-peel bucket had little effect on the conglomerate, which was then broken by a few charges of dynamite. Dredging was kept up until an area 40 ft. in diameter had been removed, leaving a depth over the raise of about 5 ft. A steel ring 16 ft. in diameter by 5 ft. high, made of ¼-in. boiler plate was then lowered by the dredge over the drill and worked down through the conglomerate to the rock by means of a water jet in the hands of the diver. To remove the layer of sandstone a charge of eight sticks of dynamite was laid on it and fired. This made no impression on the rock but burst the ring and rendered it useless. Accordingly, another charge of 110 sticks of dynamite was exploded on the rock, removing about 6 ins. of the sandstone. As this was not satisfactory another steel ring was worked down and drilling commenced inside it. This drilling was done from a large raft on which was a gin-pole 25 ft. high; the drill was jumped up and down by means of a tackle fastened to this gin-pole. When the first hole had been drilled it was found that the remaining rock layer was only 16 ins. thick instead of 3 ft. as was expected, the reason for this being that the dynamite charges laid on the lake bottom had broken from the top of the raise. As the sandstone was so thin another method of breaking through it was adopted. A piece of 4-in. shafting about 20 ft. long was fastened to the dredge rope in place of the bucket. This shafting was allowed to drop vertically about 20 ft. through the air and the remaining distance through the water. The second blow broke the sandstone floor, and little difficulty was had in removing all of the sandstone in this way. After the edges of the hole had been trimmed up a steel crib 9 ft. in diameter and 13 ft. high was then lowered and chained to the 16-ft. steel ring. It was then surrounded with concrete about 200 cu. yds. in all being used.

Ditch Construction in Alaska.—The following information regarding ditch construction in connection with hydraulic mining in Alaska is given by Mr. Chester W. Purrington in a U. S. Geological Survey Bulletin: In the construction of ditches on Seward Peninsula the ordinary road grader, the horse scrapers and the ordinary breaking plow, all being drawn by horses, are used. After the ditch line has been surveyed and staked 30 men and 20 horses, for example, with plows and scrapers, are put to work. The plows proceed ahead of the grader, and the cutting is continued until the uphill side of the ditch bottom is nearly cut to grade. The most economical work is done when the portion removed by the grader is so balanced as to demand the least cutting by the scrapers in throwing up the necessary bank. It will be seen from the above statements that the burden of the work falls on the first plows and on the grader, though the subsequent work of the scrapers and hand finishing is just as important. Four horses and one man are usually used to a grader, though eight horses are often used. The scrapers use from 2 to 4 horses, depending upon the size of the ditch. Four horses are not generally used to a scraper unless the ditch is to be 7 ft. or more wide. The plows breaking first ground usually need four horses each. It may be said that where a slope is steep very little or no cutting is needed on the lower side of the ditch, since the dirt necessary for the bank can all be obtained in reducing the upper side to grade. Special methods are necessary when the ditch passes through sections underlain by ground ice, or runs over sections of rock. Very careful work is needed when the rock is broken and fractured. It has been found bad practice to cut through the stringy moss which overlies the masses of ground ice, generally referred to as "glacier," in fact it is disastrous to the permanency of that section of the ditch, and is the beginning of never-ending repairs, since the ice continues to thaw, causing constant leakage. The best practice is to build sod walls on the lower side, leaving the moss undisturbed. All rock work must be done by hand, and where the ditch passes through fractured material all cracks must be filled with moss. Too much care can not be observed in the latter detail, and, especially during the first weeks of use, men must be kept constantly traversing and repairing those sections where leaks are apt to occur. The stirring up of the water by men walking along the bottom of the ditch is a good practice in the early stages, for silt, in addition to the sod, is a most valuable factor in filling the cracks. A scraper will work to great advantage in decayed schist, which needs no lining, as it holds water better than any other ground encountered and cuts out less. Fluming does not pay when there is a possibility of ditch building. In fact, it has been often stated by men familiar with ditch construction, that where possible, it is profitable both as regards first cost and subsequent maintenance to build a ditch in place of fluming, even if the distance necessary to be covered by the former be ten times that of the latter. Many slopes apparently not permitting a ditch cut, owing to the presence of broken rock and talus slides, on close examination are found to be favorable, for if 2 or 3 ft. of this loose material is moved there are excellent opportunities for comparatively cheap rock cuts. When, however, it is deemed impracticable to construct a ditch, and where a flume must be built crossing a gully, a very efficient foundation can be made by digging shallow holes, filling with gravel, and placing on top a wide plank to distribute the load. If the trestle rests on such foundations, and the underlying ice is not disturbed, much trouble from settling will be avoided. The following are a few of the costs representative of ditching in various materials:

	Per cu. yd.
Soft muck and tundra	$0.75
Gravelly dirt	.65
Decayed schist	$0.40 to .60
Rock work, fairly solid	1.75
Schist in place	1.00
Loose rock	1.25

A ditch carrying 1,000 miner's inches will cost, under fair conditions, $2,000 per mile. One with the capacity of 4,000 miner's inches will cost between $4,000 and $5,000 per mile. Though much affected by varying local conditions a conservative estimate for general work is $1 per cubic yard throughout.

The contract for the construction of the masonry piers, surface and subsurface changes and steel superstructures of the Manhattan and Brooklyn approaches of the new Manhattan bridge over the East River at New York City has been let to John C. Rodgers, Park Row Building, New York, at $2,167,000.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0522. **Reinforced Concrete Pipe.**—The Reinforced Concrete Pipe Co., Jackson, Mich.

This is a very handsome album of views, showing the process of manufacturing the type of reinforced concrete pipe made by the firm named above. The views show work being done in various towns and cities, and furnish a very interesting demonstration of the popularity to which this type of pipe has reached. The album is very handsomely printed, and is well worth securing.

No. 0523. **Forest Management.**—F. R. Meier, 1 Broadway, New York.

This little 8-page pamphlet sets forth concisely the advantages to be gained by the proper management of Forests.

No. 0524. **Belting.**—The McIlroy Belting & Hose Co., Chicago, Ill

This 16-page pamphlet gives price-lists, sizes and strengths of the special belting made by the company named. This belting is known as Rubberite Stitched Canvas Belting. There is a brief description of the process of manufacturing this belting. It is claimed that it is not affected by acids or alkalies and will retain its pliability for an indefinite time. The pamphlet gives some interesting facts regarding the use and care of belting.

No. 0525. **Blasting Machines.**—The Aetna Powder Co., Chicago, Ill.

The Lion blasting machine is described and illustrated in this 10-page pamphlet. Directions are given for firing and taking care of the machine, and figures of capacity are presented. Prices of the machine and its various parts are also given.

No. 0526. **Tube Mills.**—Thomas Prosser & Son, New York and Chicago.

The Tube Mill described in this 8-page pamphlet is the well-known Krupp dry grinding tube mill which has been so extensively used in this and foreign countries for grinding cement and similar refractory materials. The machine is described in an interesting manner. A separate pamphlet describes in a similar way the Krupp wet grinding tube mill. There is also a circular illustrating and describing the Krupp ball mill for cement works. The descriptive matter in these circulars is excellent.

No. 0527. **Wheelbarrows.**—The Toledo Wheelbarrow Co., Toledo, Ohio.

This company manufactures a complete line of wheelbarrows for gardners, contractors, brick works, etc. The various styles of barrows are illustrated and briefly described in this 40-page pamphlet. Weights, prices and usual other catolog matter are given. The company named above is represented in Chicago by the Contractors' General Supply Co.

No. 0528. **Spiral Riveted Pipe.**—American Spiral Pipe Works, Chicago.

Spiral riveted steel pipe is almost too well known to require special description. In this 56-page pamphlet, however, the reader will find a statement of the advantages of this style of pipe, together with tables of prices, dimensions, etc., and a large number of illustrations, showing pipe. pipe joints and pipe line work.

No. 0529. **Dump Cars.**—Continental Car & Equipment Co., New York City.

This series of circulars illustrates and describes briefly the several sizes of dump cars made by this well-known firm. Special claims are made for the durability and simplicity of these cars. There is also a circular giving a number of testimonial letters from contractors who have used these cars with success.

No. 0530. **Blue Print Machine.**—Technical Supply Co., New York City.

This 4-page circular illustrates and describes the operation of the Shaw continuous blue print machine. This machine makes blue prints of any length, and is entirely automatic in its operation. Its speed can be regulated as desired.

No. 0531. **Bitulithic Pavement.**—Warren Bros. Co., Boston, Mass.

This neatly printed pamphlet of 15 pages gives extracts from letters from various city officials who have had experience with Bitulithic pavement. There are also a number of very handsome illustrations of streets and parkways which have been paved with Bitulithic.

No. 0532. **Track Devices.**—Quincy-Manchester-Sargent Co., Chicago.

This 60-page pamphlet illustrates and gives full information regarding the large line of track devices made by the company named. The devices listed include track joints, rail braces, rail anchors, rail saws, car replacers and similar devices. At the end of the pamphlet there are a number of useful pages for trackmen. The pamphlet is well worth securing by railway maintenance of way engineers.

No. 0533. **Cast Iron Pipe.**—Central Foundry Co., New York City.

This is a cloth-bound pocket-size catalog containing 211 pages. It is devoted exclusively to cast iron soil pipe and fittings, plumbers' iron work, service boxes, valve boxes and miscellaneous castings. Each special article is illustrated and its sizes and prices are given. The catalog is an excellent one.

No. 0534. **Blue Print Machine.**—Revolute Machine Co., 523 W. 45th St., New York, N. Y.

This is a small leaflet describing the Everett-McAdam continuous electric blue print machine, that will make prints of any kind, of any length, up to a mile. The method is simple and the machine is handled by one man.

No. 0535. **Tar-rok Sub Floors.**—Barrett Manufacturing Co., New York, N. Y.

This is a 28-page catalog describing and illustrating with a number of halftone cuts, this tar concrete sub floor that has been in service for 20 years for factories, machine shop and store houses. Much of the information contained in this catalog will be found of value to engineers and architects. The book is gotten up neatly and is of an attractive appearance.

Personals.

Mr. Walter Melius has been reappointed City Engineer of Albany, N. Y.

Mr. Wallace Greenalch has been reappointed Commissioner of Public Works of Albany, N. Y.

Mr. E. L. Grimes, heretofore Chief Engineer Bureau of Water Supply, of Troy, N. Y., has been appointed City Engineer of that city.

Frank H. Radder, a well known contractor and builder of Lyons, N. Y., died Dec. 31, of tuberculosis at his home in that city, aged 47 years.

Mr. F. T. Becket has been appointed Division Engineer of the Oklahoma Division of the Atchison, Topeka & Santa Fe Ry., with headquarters at Arkansas City, Kan.

Messrs. J. L. and E. G. Parish of Jackson, Tenn., have opened an office in the Randolph Bldg., Memphis, Tenn., under the firm name of Parish Bros. & Co., and will engage in contracting work.

Mr. Charles R. Ward of 51 Clark St., Brooklyn, N. Y., has been promoted from the position of Assistant Engineer to that of Chief Engineer of the Topographical Bureau, Borough of Brooklyn, New York City.

John Lynch, pioneer cement sidewalk contractor of Chicago, died last week at his home, in that city. He was born at Lowell, Mass., in 1842, and had lived in Chicago 50 years. He is said to have laid the first cement sidewalk in Chicago.

Robert W. Hunt & Co., Inspecting and Consulting Engineers, with general offices in "The Rookery," Chicago, Ill., are to open a branch office and chemical laboratory in St. Louis, Mo. The office will be in charge of Mr. Charles W. Gennett, Jr.

Mr. James W. Howard, Consulting Engineer on Roads, Streets and Pavements, 1 Broadway, New York, who has devoted time for some years to military matters, has been promoted to be Colonel in the National Guard of New York State.

Messrs. Hazen & Whipple, Consulting Engineers, 220 Broadway, New York, announce that Weston E. Fuller, Assoc. M. Am. Soc. C. E., has been admitted to the firm, which is now composed of Allen Hazen, George C. Whipple, L. N. Babbitt and Weston E. Fuller.

Simeon P. Folsom, the first City Engineer of St. Paul, Minn., died Jan. 1, in that city. aged 88 years. He was graduated from Maine Wesleyan Seminary in 1837, and Jan. 1, 1840, came west to Prairie du Chien, Wis. He went to St. Paul in 1847, and when the town was incorporated, in 1854, he was elected City Engineer.

Richard M. Berrian, for 17 years an Assistant Engineer of Construction of the New York, New Haven & Hartford R. R., died Dec. 23, at his home in Hingham, Mass. Mr. Berrian had charge of many of the Harlem River improvements of the above road, but more recently was Engineer in Charge of the bridge at Fall River, Mass., which was constructed by the State of Massachusetts.

Messrs. James Dunne, Superintendent of Sewers of Manhattan Borough, New York City, and E. J. Fort, Chief Engineer of that department, have gone abroad to study the methods employed in London and other English cities for disposing of sewage. There has been much complaint about the pollution of the waters of Jamaica and New York Bays, and Messrs. Dunne and Fort will study the most improved sewage disposal plants to be found in England.

Mr. Chas. E. Sargent, for the past seven years Manager of the Sargent Engineering Co., Chicago, has resigned to accept the position of Chief Engineer and Manager of the Gas Engine Department of the Wisconsin Engine Co., Corliss, Wis., builders of Corliss engines, and which will now build the Sargent Complete Expansion Gas Engine, the invention of Mr. Sargent. Mr. C. E. Beck, heretofore Assistant Manager and Engineer of the Sargent Engineering Co., succeeds Mr. Sargent as Manager of that Company.

Coleman Sellers, one of the most noted mechanical engineers of this country, died Dec. 28, at his home in Philadelphia, Pa., aged 81 years. In 1856 he entered the employ of William Sellers & Co., of Philadelphia, manufacturers of machinery and machine tools, remaining with this firm for 30 years, part of which time he was Chief Engineer and a partner in the company. In 1886 he retired from active commercial business, devoting the last 20 years of his life to private practice as a Consulting Engineer. He was a charter member and past President of the American Society of Mechanical Engineers.

George W. Rafter, M. Am. Soc. C. E., one of the best known consulting engineers in this country, died recently at Carlsbad, Austria, where he had been since Dec. 16. Mr. Rafter was born in Phelps, N. Y., in 1851, and was educated in Phelps Union School, Canandaigua Academy and Cornell University. In 1873 he came to Rochester as assistant in the City Surveyor's office. In 1876 he assisted in the construction work of the Rochester water works. The two following years he was engineer in charge of the Rochester & Lake Ontario R. R., and from 1880 to 1882 he was engineer in charge of construction on the Texas Pacific and Missouri Pacific Railroads. In 1882 and 1883 he had charge of constructing the Fort Worth, Tex., waterworks system and was engineer of the waterworks at Fredonia, N. Y. He also designed the waterworks at Westfield in 1885. From June, 1888, to October, 1890, Mr. Rafter was in charge of the additional water supply for Rochester and was Acting Chief Engineer of the Rochester waterworks in the summer of 1890. He was employed as sanitary expert on the Boston waerworks in 1889 and 1890. In 1893 and 1894 he was engineer in charge of the Genesee River storage reservoir survey and was engaged in similar reservoir surveys on the Hudson. In 1894 Mr. Rafter visited England, Holland, Germany, Italy and France, making a special study of movable bridges over navigable inland canals and streams for the State Engineer of New York. He was employed on concrete studies for the State Engineer in 1896, and was in charge of the water supply division for the U. S. Board of Engineers on Deep Waterways in 1898. He was consulting engineer for the New York State Canal Committee in 1899. Since 1900 he had acted mainly as consulting engineer on waterworks and the disposal of sewage. Mr. Rafter was the author of numerous papers and books on engineering and allied subjects.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class mail matter at the Post Office at Chicago, Ill.

CONTENTS

EDITORIAL:
A Poorly Drawn Specification.........41
Lost Time 41
Collecting Water Rates...............41
CONCRETE SECTION:
A Study of a Design for a Reinforced Concrete Abutment with Some Comparative Estimates of Cost..........42
A Useful Spade for Surfacing Concrete 46
Constructing Wall Forms With Special Plank Holders 46
Cost of Grinding Gold Ore in Tube Mills 47
EARTH AND ROCK SECTION:
A High Cost of Hauling Earth with Wagons 47
Comments on the Use of Mattocks....48
A Large Cofferdam of Steel Sheet Piling 49
GENERAL ARTICLES:
Methods of Constructing Foundations for Lift Bridges with Some Figures on Costs 50
A Light Derrick Adaptable to Many Purposes 52
METHODS AND COSTS:
Stopping Leak in Coffer Dam -Rail Relaying Gang—Tile Drainage Catch Basin—Putting in Pier Masonry—Data on Street Cleaning at St. Louis, Mo. 51
CATALOGS WORTH HAVING...............52
PERSONALS 52

A Poorly Drawn Specification.

We copy the following clause from a set of specifications governing canal work.

"At the end of sluice gate walls, culverts and other designated places, sheet piling 5 ft. deep will be required, to be of sound, durable 2 in. plank. A trench will be dug to the proper depth, and the sheet piling set on end therein, and so that the edges will remain in close contact. The trench will then be filled up with stone from the old work, or with rip-rap stone, and the interstices filled with concrete, as directed. The price bid on sheet piling to cover the excavation of the trench, and the stone and concrete used in rebuilding, as well as the timber and labor."

A better example than this paragraph of a poorly drawn specification could hardly be found. It not only contains one bad feature but it has several.

Under this clause the contractor is directed to do this work in a specific manner. No matter what he may think, as to the best method, he is directed to dig his trench first, then placing the shoring, then fill in the rock and concrete. It might cost less money to drive the sheeting before making the excavation, but the engineer has assumed the management of the work, yet the contractor is held responsible.

Instead of specifying what kind of concrete and how it should be placed, it is stated that the concrete work shall be done, as directed. Nothing can be more indefinite than this, as the contractor will have to make a guess as to just what the engineer may direct, and if a change of engineers takes place, while he has the work in progress, he will be entirely at sea.

Under this clause four classes of different work are to be paid for under the head of "Sheet Piles." There could not be a worse practice for either party to a contract. Excavation should be paid for as excavation per cubic yard, and so for each of the other classes of work. This method of grouping different classes of work under one head allows of a contractor unbalancing his bid. He is compelled to bid a high price to protect himself against damages. If the excavation has to be carried deeper, the contractor will protest; if it is found that the excavation need not be taken down 5 ft., the owner will want a rebate from the contractor's price. If the plans are to be changed, or the work increased or decreased disputes are bound to arise.

Each kind of work should be paid for on a unit basis as one item. Then changes can be made and the amount of work increased or diminished without affecting either party of the contract.

In addition to these facts, these specifications should have specified the size of rock to be used in the trench. The amount of rock, place measurement, will depend upon the size of the individual pieces as well as the way in which they are placed, and this, too, will show the quantity of concrete to be mixed and placed, a fact that will have a strong bearing on the price.

Other comments could be made on this clause, but sufficient has been said to show that it is these kinds of specifications that put contract work in ill repute.

Lost Time.

Some interesting data as to the time wasted by street cleaners of Boston, Mass., are given in a report on the street cleaning department of that city. The report is the result of an independent investigation made by Mr. Richard T. Fox, of Chicago, Ill., for a citizens' committee. A systematic observation of the work of the push cart patrol was conducted for ten days, 27 of the 60 men on the patrol being followed and the manner in which they did their work noted. The men observed were taken at random and the observers were instructed not to record instances where the men stood idle for less than five minutes. The push cart patrol, it may be noted in passing, was formed to take care of those streets on which the accumulations of dirt are such that a single sweeping by a machine at night is not sufficient to keep them in proper condition. These streets are divided into definite areas and to each of these areas is assigned a man, provided with a 2-wheel cart and broom, etc. It is his duty to cover this particular area each day, removing any dirt which may come upon the street surface.

In all 32 observations were taken, the men being watched for 200 hours and 31 minutes. Of this time the men actually worked 149 hours and 7 minutes, the time lost, being practically one-fourth, or 51 hours and 24 minutes. One man who was observed for eight hours actually worked 3 hours and 33 minutes, and in this time collected 2½ bbls. of dirt. Another man observed for eight hours actually worked 4 hours and 45 minutes, and managed to collect 1 bbl. of dirt. Still another man who was watched for 5 hours and 5 minutes, spent 2 hours and 10 minutes in collecting 1¾ bbls. of dirt, the remainder of the time he was recuperating from his efforts. The hours of work for the patrol men are supposed to be from 8 to 12 and from 1 to 5. The observers found that the greatest loss was occasioned by the men taking more than one hour for lunch; in instances two hours were so spent. Talking with citizens was a favorite way of passing the time, as was reading a newspaper, taking a drink and simple loafing. One man was accommodating enough to spend 20 minutes in attending a fruit stand while the proprietor was absent.

Collecting Water Rates.

A Southern city seems to have hit upon a method—interesting to say the least—for collecting bills from delinquent water consumers. As in other cities, when the consumer fails to pay his bills, the water department turns off the supply from his house. The delinquent's name is then given to the police department and his arrest follows, on the ground that he is violating the health ordinances by failing to flush his closets. The delinquent is then brought before the city judge and given the option of paying a fat fine or settling up his water rate. The results have always been that the consumer pays his water bill and the city then remakes the connection so that the closets can be flushed as the ordinance directs.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

A Study of a Design for a Reinforced Concrete Abutment with Some Comparative Estimates of Cost.*

The abutment described in the following paper was designed by the writer in order to compare it with a standard abutment of plain concrete made by the National Transcontinental Railway Commission. The end in view was to show the greater economy of material effected by the use of concrete reinforced. The design is detailed in the attached drawings.

Formula.—The formula which these calculations are based upon depends on the following assumptions: (1) The sections plane before bending are plane after bending; (2) Total tension must equal total compression, thus fixing the neutral axis.

The stress strain curve is a parabola, or in other words, the compression stresses vary as the ordinates to a parabola, whose vertex is either at the top of the beam or above it. It is also assumed that the concrete is subjected to tensile stress from the neutral axis to a point in the section where the elongation is the same as that developed by a plain beam in cross bending. This tensile value of the concrete is only assumed to make the formula as nearly correct theoretically, as possible—it has very little effect on the size of beam and amount of steel—less than 1 per cent in fact. To obtain an equation for a parabola that would represent the variations of the modulus of elasticity of the concrete, it was considered that the modulus at rupture, was two-thirds the initial modulus, that the resulting parabola represents closely the actual stress-strain diagram.

Fig. 1—General Plan of Concrete Abutment.

This formula is only applied to the ultimate strength of the beam, reinforced with what may be termed the critical percentage of steel. This percentage is such that when the steel reaches its elastic limit, the compressive stress on the extreme fibre of the concrete becomes its ultimate strength.

The compressive and tensile areas are calculated, and the compressive and tensile stresses are equated. The moment of resistance is found by taking moments about the center of gravity of the compressive stresses, giving the following general equation:

$$M_o = pdbF(d - z) + by_1G\left(y_1 + \tfrac{3}{4}y_1\frac{\Delta_t}{\Delta_e} - z\right)$$

Where

M_o = resisting moment of beam (ultimate).

p = ratio of reinforcement in terms b d.

$d = y_1 + y_2$ effective depth of beam

b = width of beam.

F = elastic limit of steel in pounds per square inch.

z = distance from extreme fibre in compression to center of gravity of compression area.

y_1 = distance from neutral axis to extreme fibre in compression

$$G = \frac{E_e\Delta_t}{2\Delta}.$$

E_e = initial modulus of elasticity of concrete in compression.

Δ_t = unit of elongation of concrete in tension at rupture.

Δ_e = unit of elongation or concrete in compression at rupture.

The above formula may seem rather complicated, but for any ultimate strength of concrete and elastic limit of steel it can be reduced to simpler ones, making the solution of beams comparatively easy.

In the following calculations it is assumed that average rock concrete is to be used. The ultimate strength of this concrete in compression is taken at 2,000 lbs. per sq. in. in cross bending, and the initial modulus of elasticity is taken at 2,600,000. These are conservative values for a mixture of 1 part Portland cement, 3 parts sand, and 6 parts broken stone. For the steel the modulus of elasticity was assumed as 29,000,000, and the elastic limit at 55,000 lbs. per sq. in. From the general formula the following can be derived using these constants:

$$\left.\begin{array}{l} y_1 = .3782d \\ g = .00785bd \\ M_o = .376bd^2 \end{array}\right\} \begin{array}{l} \text{If } b = 12 \\ \text{and } e = \dfrac{h}{12} \\ \text{we have} \end{array} \left\{\begin{array}{l} y_1 = .3404h \\ g = .08478h - .7065\% \text{ of} \\ \qquad \text{cross-section} \\ M_o = 3655h^2 \\ h = 0.01654\sqrt{M} \end{array}\right\}$$

From these a table can be arranged from which the reinforcement necessary for any size of beam can be easily determined.

Steel.—It will be noticed from the above that steel with an elastic limit of 50,000 lbs. per sq. in. has been employed in this design. It, of course, stands to reason that as the ultimate strength of the beam depends on the elastic limit of the steel, the higher this elastic limit is the more economical it will be.

To the use of high carbon or high elastic limit steel the objections may be made that it is not reliable, and that its full value may not be developed owing to insufficient adhesion.

Several years ago it was thought that economy could be effected by employing high carbon steel for bridge work. It was found, however, that owing to punching and the irregular stresses produced in plates and structural shapes, high carbon steel was unreliable. For this reason some engineers condemn its use for reinforced concrete. It should be remembered, though, that in this class of work there is no punching of the steel necessary. The stresses in the steel are nearly all tensile, and the ability of the steel to safely withstand them has been proven many times over. Shearing stresses need never be considered either, as they are always far within the shearing strength of the steel.

The steel considered in these designs is the Johnson corrugated bar, which has an elastic limit of 50-6,500 lbs per sq. in., and an ultimate strength of 90-100,000 lbs.

The objection that adhesion may not be sufficient to develop the full strength necessary of high elastic limit steel, is easily overcome by furnishing a suitable mechanical bond. An intimate union or bond between concrete and steel is of first importance, especially as failure of bond or lack of it may often have disastrous effects. Plain round or square bars depend on adhesion for the union of steel and concrete. This adhesion is partly due to friction, but chiefly to a mechanical bond, formed by the grout of the concrete entering into the irregularities on the surface of the bar. There are three influences affecting the adhesion and making a mechanical bond advisable: first, water percolating through the concrete (no concrete is perfectly watertight) has been proven to reduce the bond between one-half and two-thirds; second, reinforcing bars when stressed, even within their elastic limit, must have their cross-section slightly reduced, and any shrinkage of the cross-section of the metal, however slight, is sufficient to materially affect the adhesion, inasmuch as the adhesion consists principally in the entering of the cement particles into the pores on the surface of the metal. If the metal has a working stress of 15,000 lbs. per. sq. in., then the proportionate elongation is .0005 per unit of length, with a decrease in diameter of practically one-half or .00025, by no means a negligible quantity.

Finally vibrations and shocks have also been proven to affect the adhesion. This last would alone warrant the adoption of mechanical bond reinforcement for railroad structures. To the above reasons may be added the many chances of bars being disturbed in partially set concrete during construction. From the foregoing it would seem wise to adopt a style of reinforcement with a suitable mechanical bond.

---

*Abstracted from a paper presented before the Canadian Society of Civil Engineers by Mr. T. M. Fyshe.

General Conditions.—The general dimensions for the design were taken from the set of Standard Abutments of the National Transcontinental Railway Commission, which were very kindly furnished the writer by Mr. H. D. Lumsden, Chief Engineer.

A rather high abutment was chosen as the economy of reinforced concrete construction increases with the height of the structure. The distance from the ground level to sub-grade was taken at 50 ft. 1 in., the span allowed for is a 100-ft. deck plate girder with the girders 9 ft. c. to c., and the same width and depth of bridge seat was allowed as that shown on the standards referred to. The distance from the groundline to the bottom of the foundations was assumed as 5 ft., as shown on the standard plan, but this distance is, of course, an assumption. It depends entirely on local conditions, and would vary accordingly. The wing walls of the abutment slope back at an angle of 60° to the track. These walls are stopped at a height from which a 1½ to 1 slope will fall inside the line tangent to the face wall of the abutment at the ground line. This is the only point of difference from the standard plan. In it the wing walls are run out to a height of 4 ft. above the groundline. This seems hardly necessary, as by the former method a clearance equal to that between the 2 face walls is maintained, which in most cases will be all that is necessary. An allowance for this reduction in quantity has been made in the comparison of quantities and cost further on.

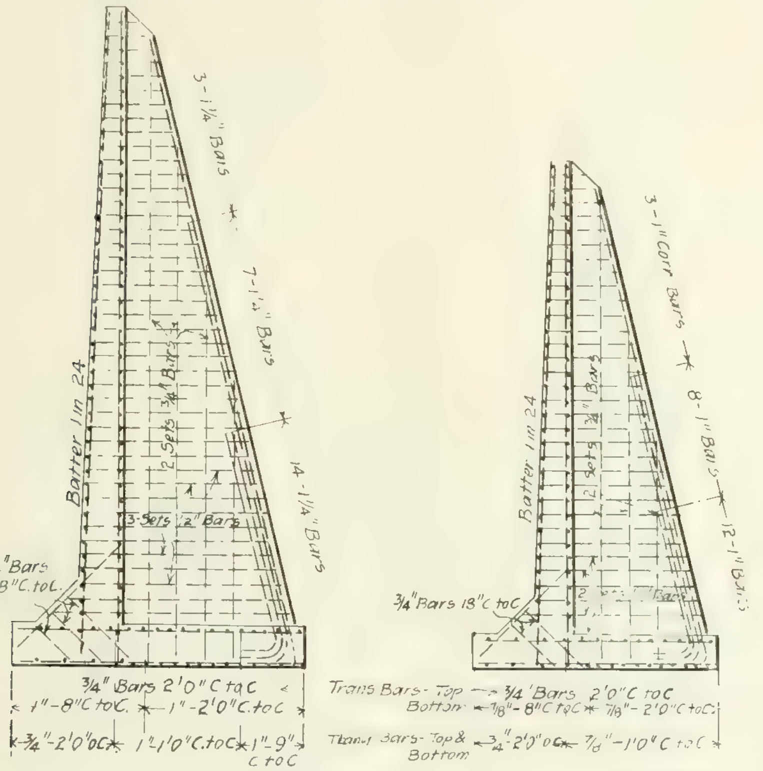


Fig. 2—Typical Sections of Concrete Abutments.

In the following discussion the general methods and assumptions for designing all parts of the abutment have been given. Although the whole has been worked out in detail, in order to make a proper detail drawing, where calculations of the same nature are necessary, more than once they have not been carried out in the discussion.

Foundations.—From the diagrams of sections on Fig. 3 it will be seen that owing to height of the abutment the resulting soil pressures are so great that in most cases, unless the foundation consisted of cemented gravel or rock, pile foundations would have to be used. Therefore, in order to make this design as modern as possible, the use of concrete piles for this purpose will first be considered. The use of concrete piles may not in all cases be economical, especially in localities where good timber piles are available and not too expensive. In a majority of cases, however, their use will be found satisfactory where the following conditions obtain: where timber piles are scarce and consequently expensive, where the distance between low water line and ground level at face of abutment is considerable, and when a concrete pile is used that gives a bearing capacity much larger than that of an ordinary wooden pile.

Design.—In general, the abutment has been designed as follows: The base is about one-half the height. This dimension is greater than the 4/10 usually allowed for solid masonry abutments, and therefore makes the structure much more stable. This extension of base is also very easily obtained without much extra cost. Two main buttresses support the bridge seat and are placed directly underneath the centres of bearing of the girders. A face wall connects these buttresses to take care of horizontal earth pressures and live load pressures transmitted through the earth. The face wall supported by buttresses is continued, forming the wing walls. The buttresses and face wall rest on a continuous base which resists the earth pressures. At the back of the bridge seat is a parapet wall supported by buttresses which runs into the wing walls. The face wall is thoroughly tied to the buttresses by reinforcing bars. As the height of this abutment is considerable and the resultant horizontal thrust would therefore be large, a shelf has been placed between the four centre buttresses to reduce the overturning moment. This takes somewhat more material, but effects an economy by reducing the extreme soil-pressures and the steel necessary in the buttresses to withstand the overturning moment.

The stability of the abutment has been examined at the buttresses A, B, C, and E. The resultant pressure lines and soil pressures, etc., for these sections are shown by Fig. 3. The formula used for determining stresses in earthwork is Rankine's, principally because it is the safest formula, giving beyond doubt pressures in excess of actual working conditions.

Let P = resultant pressure on wall in pounds.
p = pressure per square foot of horizontal pressure on wall in pounds.
W = weight of earth per cubic foot.
h = height of wall.
θ = angle of surface of backfilling.
ϕ = angle of repose of material.
then at any height h:

$$P = \frac{W h^2}{2} \cos\theta \frac{\text{Cos}\,\theta - \sqrt{\text{Cos}^2\theta - \text{Cos}^2\phi}}{\text{Cos}\,\theta + \sqrt{\text{Cos}^2\theta - \text{Cos}^2\phi}}$$

In this discussion the worst condition was assumed, *i. e.*, that the line of cleavage of the material behind the wall is a slope of 30° to the horizontal, or that $\phi = 30°$.

At the top of the embankment θ is of course $= 0°$; this, although perhaps not quite correct, was also assumed at the other sections on account of shortening the work necessary.

The above formula then becomes—

$$P = \frac{w h^2}{6} \text{ and } p = \frac{w h}{3}$$

or the horizontal pressure per square foot at any depth on the face wall of the abutment is one-third of the vertical pressure per square foot at the same point. This assumption was also made figuring the live load pressures on the abutment.

In examining the section at buttress "A" two cases were worked out. First, the bridge was considered fully loaded with no live load on the track behind the abutment; second, the bridge was fully loaded together with a live load of 10,000 lbs. per lin. ft. of track behind the abutment. The total dead load of the girder span was assumed as 200,000 lbs., and the live load of the span fully loaded as 610,000 lbs., making a load on each main buttress of 202,500 lbs. The live load of 10,000 lbs. per lin. ft. of track was considered distributed over 18 ft., giving a vertical intensity of 555 lbs. per sq. ft., and a horizontal intensity of 185 lbs. per sq. ft. The shelf between the buttresses was considered to relieve the wall from the effects of the live load below it, and to reduce the intensity of the earth pressure. The horizontal pressure below the shelf was figured as the same, due to a height of earth equal to the height of the shelf above the base. Of the two cases considered at buttress "A," the second gave a greater extreme soil pressure, namely, 11,590 lbs. per sq. ft. The resultant pressure line, however, intersects the base inside of the middle third. Referring to this, another advantage of reinforced concrete walls is obvious. As they are capable of taking tensile stresses, it is not of such importance as in plain masonry that the resultant pressure line should intersect the base within the middle third. All that has to be taken care of is that the extreme soil pressure does not exceed the safe allowable bearing capacity of the foundation soil.

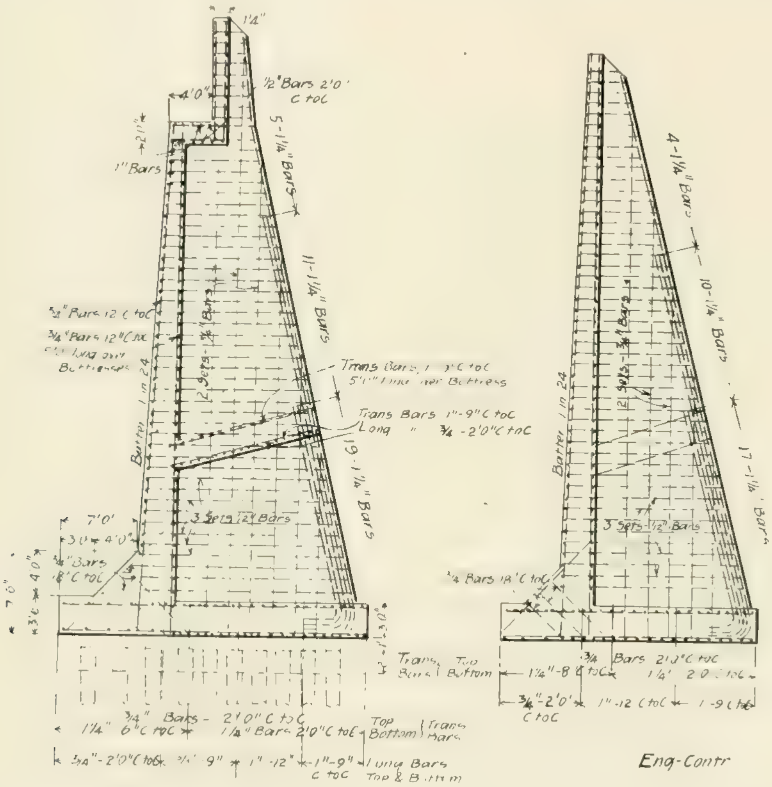


Fig. 2—Typical Sections of Concrete Abutments.

Sections at buttresses B, C, and E were examined in a similar manner to the one mentioned. It was assumed that the live load would not have any effect beyond the buttresses "B" so that at "C" and "E," earth pressures were alone figured on. It will be noticed that in these other sections the resultant pressure line does not intersect the base within the middle third, but as the soil pressures do not exceed the maximum at buttress "A," it may be considered that the wall will not suffer from this. The diagrams of Fig. 3 show the maximum upward soil pressures, also the downward earth pressures on the base due to the weight of the earth fill on top.

Parapet Wall.—This consists of a 16 in. wall supported by the continuations of two of the main buttresses. This wall is designed as a horizontal beam supported by the buttresses, which are 9 ft. c. to c. In nearly all reinforced concrete structures beams act as continuous ones, due to the method of construction. It is, however, difficult to say exactly how much this continuity can be relied upon. Some designers neglect it altogether and figure the beam as one simply supported. It seems, however, better and more general practice to figure the moment of resistance of such a beam as $\frac{1}{10}wl^2$, reinforcing it so that the continuity can be taken full advantage of.

Size of parapet wall necessary at bottom. Height of earth fill = to about 10 ft.

Horz. pressure $= \frac{10 \times 100}{3} = 333$ lbs. per sq. ft.

The vertical pressure due to live load at this point is assumed as 10,000 distributed over 13 ft. $= \frac{10,000}{13} = 770$ lbs. per sq. ft.

Horizontal pressures are due to L.L. $= \frac{770}{3} = 257$ lbs.

To this live load pressure was added 50 per cent to allow for the effect of impact. Total load, therefore = 718 lbs. per sq. ft. In the calculations throughout a factor of safety of 4 has been allowed.

The ultimate moment on a strip of wall 1 ft. wide $= \frac{1}{10}\, 718 \times 81 \times 12 \times 4 = 232,600$ in. lbs.

This requires a beam 8 ins. deep with 0.68 sq. in. of metal per sq. ft. The thickness of the parapet wall is 16 ins., but as, in order to prevent exposure of reinforcing metal, all bars are to be placed 3 ins. in the clear from exposed surfaces, the effective depth of the wall is say 14 ins. The steel can therefore be reduced. This is done proportionately to the depth, as the amount of steel necessary varies directly as the depth. Steel necessary therefore is $\frac{8}{14} \times .68$ $= .39$ sq. in. per foot.

In designing reinforced concrete, it is always important to examine shearing stresses, as they very often are the limiting factors for beams. The average shear on any section should never exceed 60 lbs. per sq. in. If it does exceed this amount, shear reinforcement should be used. Shear on 12 in. of parapet wall $= \frac{3.5 \times 7.18}{16 \times 12} = 13$ lbs.

Face Wall.—The face wall is designed by the same method as the parapet wall. It was considered better to make this wall somewhat stronger than figured, due to the fact that besides being subjected to cross bending, it is in compression due to its own dead load, and also in compression due to its T-beam action in conjunction with the buttress. For this reason a batter of 1 in 24 was put on the face. Horizontal bars are hooked over the bars in the face wall and run back into the buttress. These were figured strong enough to take the horizontal reaction of the wall between buttresses, without depending on the tensile strength of the concrete. Impact loads were not considered below the parapet wall, as at that depth they will be pretty well dissipated in the embankment. The greatest stress in the face wall in the center of the abutment will be found according to the assumption made, just above the relieving shelf. When figured as already shown, the amount of metal necessary per square foot was 0.43 sq. in. per sq. ft; ¾ in. bars 12 ins. on centres are used in face and parapet walls to take care of cross-bending. This is somewhat more than actually figured; but as the increase of metal increases the cost only slightly, it is generally better to incur a small increase in cost and be on the safe side. To tie the face wall together vertical ½ in. bars 2 ft. on centres are used, and to take care of the reverse moment over the supports, ¾ in. bars 12 ins. on centers 5 ft. long are used.

Bridge Seat.—The main buttresses are large enough, and are designed to carry the bridge loads directly to the base, so the bridge seat has no direct load to carry. In this case it was made 2 ft. thick. It should be strong enough to tie the structure together thoroughly and for that reason it is well to reinforce it so, that if the necessity arises, it will be capable of developing its full strength.

Reinforcement necessary for this is 22x .085 = 1.82 sq. ins. per sq. ft.; 1 in. bars 6½ ins. on centers are used with transverse, ½ in. bars 2 ft. on centers.

The bridge seat may be figured for a possible displacement of the girder.

Dead load = 50,000 lbs. Supposing a displacement of 3 ft. were possible equal to 33000 x 36 x 4 = 4,800,000 in. lbs. This would be distributed over 2 ft. 6 ins. of bridge seat, and would need a depth of about 23 ins. with about the same reinforcement as above, then shear would be $\frac{33000}{30 \times 24} = 46$ lbs. per sq. in.

Base.—The base should be of sufficient width to properly distribute the load within the safe bearing values of the material. The base between buttresses behind the by the buttresses to take the upward or downward pressure, as the case may be. At A there is a maximum upward pressure of 5,550 lbs. behind the wall, and a maximum downward pressure of 5.800 lbs. per sq. ft. at the end of the base.

$$\text{Span} = 9 \text{ ft. } M_u = \frac{1}{10} \times 5800 \times 81 \times 12 \times 4$$

= 2,250,000 in. lbs.

face wall is figured as a beam supported

$$\text{Shear} = \frac{5800 \times 35}{36 \times 12} = 47 \text{ lbs. per sq. in.}$$

Amount of steel necessary for a 36 in. beam to take this load = 1.4 sq. in. per sq. ft.; 1 in. bars 9 ins. on centres. The top and bottom of the base are reinforced this way, the spacing of the bars in the centre being somewhat further apart, as the loads to which the base is subjected are not so great. The vertical bars in the buttresses at the base. In reality they will most likely act in conjunction with face as T-beams, the face wall taking the compression. It will be safer, however, to figure the buttress as a simple beam. The factor of safety in figuring the ultimate moment has been reduced to 3 in this case, as this moment is greatly in excess of the moment of stability of the abutment, as a whole, and, therefore, it is not advisable to design any member to resist a very much greater overturning moment than the stability of the abutment as a whole will allow. Buttress A: Depth at base = 20 ft. and width = 2 ft.

$M_u = 325000 \times 26.7 \times 12 \times 3 = 302{,}390{,}000$ in. lbs. or 151,200,000 in. lbs. on 12 ins.

Depth necessary = 202 ins. Area of steel

$$= \frac{202}{240} \times 17.17 = 14.55 \text{ sq. ins.}$$

Therefore total area necessary = 29.0 sq. ins. or 19 — 1¼ in. bars.

These bars are extended far enough into

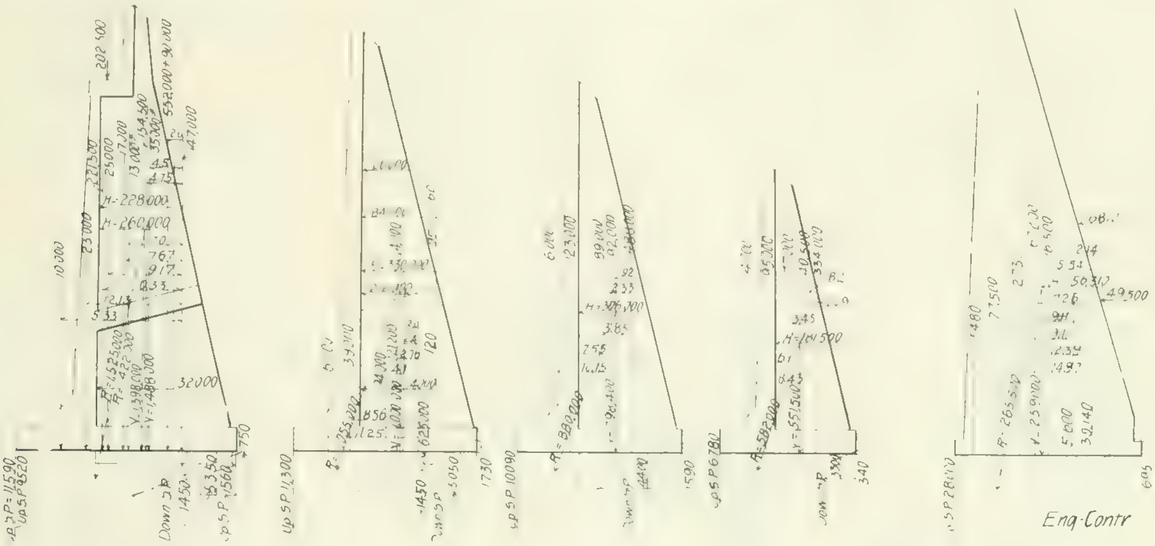


Fig. 3—Diagrams Showing Pressure Lines and Pressures for Concrete Abutments.

In this example, owing to the height of the abutment, the loads are so excessive, that if a rock foundation were not available, piles would be used. Assume a foundation of sufficient bearing capacity.

Average soil pressure on projection of base beyond face wall at buttress A = 10,300 lbs. per sq. ft. This projection is assumed to act as a cantilever. Projection is 7 ft. In this case shear will be found to be the limiting factor.

Assuming the thickness at the face wall to be 7 ft. 6 ins., average shear on 12 ins.

$$= \frac{10\ 300 \times 7.}{90 \times 12} = 66 \text{ lbs.}$$

Shear reinforcement has been used here as shown by Fig. 2.

Ultimate moment on 12 ins. = 10300 x 7 x 3.5 x 12 x 4 = 12,200,000 in. lbs.

Steel necessary to take tension $= \frac{58}{90} \times$ 4.92 = 316 sq. ins. per sq. ft. or 1¼ in. bars 6½ ins. on centres.

should be carried through and hooked over longitudinal bars in the base.

The shelf between centre buttresses is figured as a horizontal beam, carrying a dead load of 3,900 lbs. per sq. ft., and a live load of 550 lbs. per sq. ft. The thickness of this shelf is 30 ins., and the amount of reinforcement necessary is 1 in. bars 9 ins. on centres.

Buttresses.—The main buttresses should in all cases be placed directly under the bed plates of the girders; they are widened out at the bottom to distribute their load on the base, and are reinforced by bars placed in the rear, anchored in the base, to take care of the overturning moment. In case of through spans, it will be found necessary to place an additional buttress between the two main ones. The wing walls are similarly treated, buttresses being placed 9 to 10 ft. on centres sufficiently reinforced, to resist the overturning moment due to horizontal earth pressures. The buttresses were figured as cantilevers fixed the base to have sufficient anchorage to develop their full tensile strength. The buttresses for the wing walls are designed similarly.

In constructing an abutment on the above design, care should be taken to ensure sufficient anchorage against slipping along the foundation line by sinking the foundation into the rock if there is rock foundation, or by building a toe along the front of the wall in other material, and providing for good drainage of the foundation. If piles are used, the shear along the foundation line should be examined.

Comparison of Standard Plain Concrete Abutment and Reinforced Concrete Abutment.—Initial cost is generally the principal and most important point of comparison, and in this respect the reinforced concrete abutment makes a very creditable showing. The contents of the standard abutment from the standard plan is 1,786 cubic yds. Making an allowance of 142 cu. yds. for the shortening of the wing walls as indicated, the basis of comparison would be 1,644 cu. yds. A rough estimate of the attached design places the quantities at 1,060 cu. yds. of concrete, and 101,200 lbs. of steel.

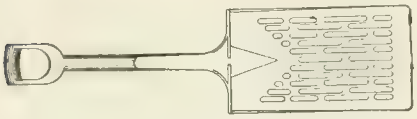
The contract prices per yard of concrete on the National Transcontinental Railway are $10 on the eastern section, and $12 on the western section. These figures are used. An allowance of 50 cts. per yard has been made for the increased cost in placing concrete reinforced. The cost of steel, including placing, has been figured at 4 cts. per pound. On the basis of $10 a yard, the standard abutment will then cost $16,440, and the reinforced concrete abutment $14,657, effecting a saving of $1,783. On the basis of $12 per yard these figures are $19,728 and $16,687 respectively, and the difference in cost is $3,041. In the first case the standard abutment is 17 per cent, and in the second 18 per cent more expensive.

Another advantage of the reinforced abutment is its greater stability, as can be seen by comparing its section at the centre with centre section of the standard abutment as shown by Fig. 3. Both these sections were examined, using the same assumptions. To this may be added the saving that would be effected if pile foundations were necessary, the standard abutment having a great dead load and a much greater extreme soil pressure.

These points of advantage should be sufficient to convince any railway engineer of the great advantages of reinforced concrete construction, and of the great possibilities of this material.

A Useful Spade for Surfacing Concrete.

In placing concrete in wall forms it is necessary in order to secure a good surface, when no special facing or finish is planned, to work the coarse material back from the lagging so that the mortar will flush to the surface, and no coarse stone show on the face of the finished work. The usual method of performing this task is to work back the stone by thrusting a spade between the wet concrete and the lagging and pull back the stones allowing the liquid mortar to flow into the vacant space. The tools used are various; they comprise the ordinary flat square pointed spade, spading forks, hoes with blades bent back to a position in line with the handle, etc. None of these tools has been especially designed for the work and each of them is faulty in some particular; the solid bladed tools because the liquid mortar can get into the vacant space only by flowing around the edges and the spading fork because the openings are so large that many of the stones slip through to the front.



Spade for Surfacing Concrete.

To remedy these faults a special finishing spade shown by the accompanying cut has been put on the market by the Concrete Spade Mfg. Co., Chicago, Ill. As will be seen, the tool is simply a spade with a perforated blade. It is used in the usual manner described above, and because the perforations are narrow none of the stone slip through while ample opportunity is had by the liquid mortar to get to the front. This spade costs $3.

Constructing Wall Forms with Special Plank Holders.

The accompanying sketch, Fig. 1, shows a method of using plank holders in constructing wall forms without studding. The holders are made of malleable iron and are the invention of Thomas C. Farrell, contractor, Washington, N. J. The mode of operation in wall construction is as follows:

Scantlings, 2 x 4 ins., are cut to length and leveled up exactly for a ground course entirely around the building. On these scantlings set edgewise holders are placed at every angle and at such points as necessary in intermediate straight lengths and are tie bolted together across the wall. Between holders strips of lath are nailed on top of the scantlings, so as to bring the top edge of the ground form flush with the horizontal webs of the holders and make a close joint with the bottom of the first form plank. The ground form is then poured and tamped flush with concrete entirely around the building. A course of 2 x 10 in. planks is then set into the holders on both sides of the wall and entirely around the building, and on top of these are placed another set of holders tie-bolted across the wall. This 10-in. course is concreted and a second course of planks is erected like the first. After 2 to 5 courses of planks have been set and filled the plank for succeeding top courses are obtained by removing the bottom course planks and transferring them up. The tie bolts used have square heads and square or wing nuts as desired. They are driven free of the wall with a hammer and the holes used when desired for bolts supporting staging brackets. The bolt holes are filled by pointing with plaster, and the imprint of the holder on the face of the wall is also plastered flush, or the inside of the planks can be veneered flush with the webs of the holders.

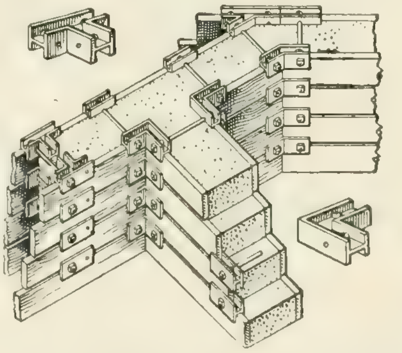


Fig. 1—Farrell's Plank Holder for Wall Forms.

The following estimate is made by Mr. Farrell of the cost of wall form construction by this method:

Size of building 40 x 40 ft. x 31 ft. high with two gables, 40 x 20 ft. gives for 12-in. walls.

40 x 40 x 31 ft. walls	4,960 cu. ft.
40 x 20 ft. gables, two	800 cu. ft.
Total	5,760 cu. ft.

This amounts to 213⅓ cu. yds. of wall volume and 11,520 sq. ft. of face form work. Two courses of forms requiring three courses of holders are assumed. The items of cost would then be as follows:

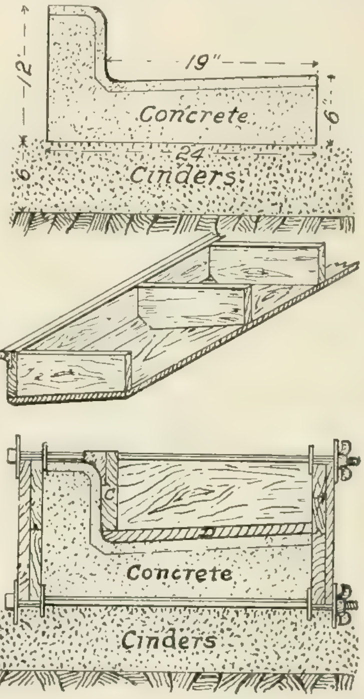


Fig. 2—Form for Concrete Curb and Gutter, Using Plank Holders.

192 holders style 4 at 50 cts.	$96.00
12 holders style 3	11.50
12 holders style 5	9.60
Freight and hauling	2.90
Total, 216 holders	$120.00
108 ⅝x7 in. bolts at 5.9 cts.	$ 6.50
108 wing nuts	3.50
Freight and hauling, say	1.00
Total 108 bolts	$11.00
2 courses, 640 lin. ft., 2 x 12 in. plank, 1,280 ft. B. M. at $30	$38.40
1 course, 320 lin. ft., 2 x 4 in., scantling, 214 ft. B. M. at $30	6.42
Total, 1,494 ft. B. M.	$44.88
Foreman and one laborer laying out and setting up forms, 9 hrs. each	$ 5.50
Grand total	$181.34

This gives unit costs per cubic yard of concrete as follows:

Item.	Total.	Per Cu. Yd.
Holders, 15% of cost	$18.00	$0.085
Bolts, 25% of cost	2.75	0.013
Lumber, 33⅓% of cost	15.00	0.070
Labor	5.50	0.026
Total	$41.25	$0.104

The cost of forms per square foot of face comes to about 0.35 ct.

The plank holders described can be adapted to various other kinds of building form work. Figure 2 shows their adaptation to form construction for combined concrete curb and gutter.

Cost of Grinding Gold Ore in Tube Mills.

The extensive use of tube mills for grinding cement makes the following figures of the cost of tube-milling gold ore of general interest. These figures are taken from a paper read before the American Mining Congress at its Denver, Colo., meeting in 1906 by Mr. F. L. Bosqui. We quote as follows:

"The cost of tube milling is variable. In this country and Mexico it will range between 20 and 40 cts. per ton. The practice at El Oro, Mexico, and at Telluride, Colo., is representative of the best practice on this continent, while the figures on tube milling at the Combination mine, Goldfield, Nev., probably represent the maximum of cost, owing to high price of power and labor. A small 4 x 12-ft. trunnion mill is installed at the latter property for sliming the forty-mesh product from a Bryan mill. The product of ten stamps, about 35 tons of ore per day, passes to the tube mill classifier, and of this product about 75 per cent goes to the tube mill, or 24.6 tons per day. The following figures may be of interest:

"Cost of 2½-in. silex lining laid in mill, $323.50; life of lining, 4 months; cost of lining, 7.7 cts. per ton of ore stamped; cost of pebbles delivered Goldfield, $71.00 per ton; consumption of pebbles, 2.03 lb. per ton of ore stamped; cost of pebbles, 7.1 cts. per ton of ore stamped; horsepower: 25 h. p. at $11.25 per h. p. per month; cost of horse power, 26.7 cts. per ton of ore stamped; summary: Cost per ton of ore stamped—

Pebbles	$0.071
Lining	.077
Power	.267
Total per ton	$0.415

"Tending the mill is one of the several duties falling upon one man; and the consumption of lubricants is almost negligible. I have, therefore, not included these two items in the cost. This cost of 41 cts. per ton may be assumed to be the maximum for tube milling, owing to the very high cost of labor and freightage in the southern Nevada camps."

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

A High Cost of Hauling Earth with Wagons.

A high cost of doing a piece of work is at times as instructive as a low cost. When the work is well managed, and the cost is excessive it sometimes means that the work has been poorly planned. If such is the case, the facts can seldom be brought out except by the keeping of detail costs, and then afterwards having these costs analyzed and compared with other costs of similar details. An engineer cannot depend upon contract prices to guide him entirely in such matters, as too many contractors, even of high standing, base their bids upon guesses and impressions rather than upon an analysis of similar work, with the result that their contract prices may give but little idea of the relative cost of work. They are as liable to be too high as too low. Then, too, contractors sometimes unbalance their bids to prevent their competitors and the engineers from knowing the real value or price they have set upon certain work.

The engineer can then only inform himself, as previously stated, by having a cost record kept of the work. This is so of earth work, which varies much in cost according to the method of doing the work, and the local conditions surrounding it, yet the various details that go to make up the costs can by study be learnt accurately, and applied with a little experience and judgment to any piece of work.

In this article the cost in detail is to be given of some earth excavation on a railroad. There were 1,006 cu. yds. of material to be excavated from a cut and placed in an embankment 2,600 ft. away. The work was done in the early part of April, when the ground was still cold and wet from the winter snows and rains. The material was a stiff clay, and it would have been almost impossible to have hauled it over the roadbed; a convenient wagon road from the cut to the fill, of the same length as the haul on the roadbed, however, allowed by the haul being made over it.

Patent dump wagons of 1½ cu. yds. capacity, with sideboards, were used to haul the dirt. At first two horses were used with these wagons, but as the road became cut up the number of wagons was reduced and the extra horses added to the other teams, making some three horse wagons and some four horse wagons. By loading the wagons to their utmost capacity the shovelers were thus kept busy, but the cost of hauling was increased.

The road finally became so cut up from the wagons, that the ruts had to be filled, and in some places ashes had to be bought, and put in these bad spots. Fortunately the railroad track was laid down to the cut, so ashes could be brought to the work over the railroad. The cost of this repairing to the road is given below.

The earth was loosened by plowing, a four horse plow team being used, but this team also did the plowing for another gang of men, on an adjoining piece of work. This cut the cost of loosening the earth in half.

The wages paid for a ten hour day are listed in the cost of the work given below. An extra foreman was used for two days when the roads were bad, and before the ashes were put in place, to look after the teams on the road and on the dump. Another foreman looked after the road repairing. Nine or ten men made up the gang of shovelers. While the work was going on rain interfered with it, there being 3 or 4 rainy days, and twice it rained at night. This helped to make the clay heavier, consequently harder to shovel, and put the roads in worse condition.

The cost of the work was as follows:

Foreman, 14 days, @ $3.00	$ 42.00
Shovelers, 134 days, @ $1.50	201.00
Dumpmen, 30½ days, @ $1.50	45.75
Plowing, 7 days, @ $9.00	63.00
2 horse wagons, 86 days, @ $4.50	387.00
3 horse wagons, 3 days, @ $6.00	18.00
4 horse wagons, 11 days, @ $7.50	82.50
Total	$845.25

Cost of work on wagon road was:

Foreman, 2 days, @ $3.00	$ 6.00
Foreman, 2 days, @ $2.50	5.00
Teams, 2 days, @ $4.50	9.00
Men, 10 days, @ $1.50	15.00
2 carloads ashes @ $5.00	10.00
Total	$ 45.00
Grand total	$890.25

The cost per cubic yard for each item was:

Foreman	$0.042
Loosening	0.063
Loading	0.201
Dumping	0.046
Transporting:	
Hauling	0.487
Repairs to road	0.045
Total per cu. yd.	$0.884

To the above cost must be added a small percentage for superintendence and general expense.

The cost of shoveling shows an output per man day of 7½ cu. yds. In this same material when it was dry and well loosened a man would shovel into a cart from 12 to 14 cu. yds. per day, but on this piece of [illegible] the ground was wet and so the clay was heavy and the loosening was done entirely with the plow. In such material a plow breaks the ground into big clods and very little fine material, thus making shoveling harder and more expensive. A dump wagon with side boards is higher than a dump cart, hence this fact also means a reduction in the yardage shoveled per man day. The output of from 7 to 8 cu. yds. per day seems fair.

The plow loosened for this job about 75 cu. yds. per day, and as it was also doing work for another gang it is but right to assume that it loosened as much material for the other gang, making a total of about 150 cu. yds. loosened by the plow. This is a small day's work for such a plow, and it could have done more.

The men on the dump, and there were generally two, each handled about 33 cu. yds. The embankment was made over a tide water marsh and it took two men to keep the material spread out, and a few days when the clay was very wet three men were needed.

The hauling cost 2 cts. per 100 feet of haul per cubic yard. This was high, but the reasons for this have already been explained. This cost shows in a striking manner how expensive hauling of earth can become when the haul is long and it is made under unfavorable conditions. The number of wagon days was exactly 100, this meant that 10 cu. yds. was hauled per wagon per day. As 86 per cent of these loads were hauled with 2 horses, the average load was not over 1 cu. yd. place measurement; this would make 10 round trips per day for each team, which would mean that the horses traveled 10 miles. This is enough to show the bad condition of the roads, as a team should make from 18 to 20 miles per day, and it is possible for it to make more.

This is a high cost for moving earth on a railroad, and it is needless to say that the cost exceeded the contractor's price, although he no doubt had figured on some of these excessive costs occurring, as he made money on his entire grading contract. This shows then that it may have been the fault of the engineer that this cost was so high. This earth could have been wasted along side of the cut, even at that time of the year, for less than it cost to haul it. Then if it was possible to get a borrow, material could have been borrowed for the embankment at a nearby point. This would have meant the excavation of two yards instead of one, but the cost of this total yardage would have been less, done with scrapers, than the 1,006 cu. yds. done with wagons, even including a fair price paid for the borrow pit.

If land could not be purchased for a borrow, then the engineer was compelled to have the earth hauled, and no blame can be put upon him, but an example of this character shows how important it is to consider all of these things. One such job on several miles of construction means to raise the bid price on grading many cents, and if it is possible to prevent this, the engineer should use his best endeavors to do so. The keeping of costs will not only impress these things on his mind, but will put him in a better condition to judge of their merits.

Comments on the Use of the Mattock.

In using many of the small tools for excavation, many mistakes are often made, from either thoughtlessness or by not being posted as to the adaptability of the tools. This adds to the cost of the earth work, but the added cost is generally only to some one detail or factor, and it is often lost sight of, inasmuch as the added cost is small for each unit, and only because noticeable on a large job. Even then it is difficult to tell that the work is costing more than it should, unless cost data is kept and kept to show every detail of the work and its cost.

Contractors often say that their methods of doing work, and the system they use, are bound to be the correct ones, for they are making money, and that is the supreme test. That is a test as to whether their methods and system are better than those under which money is lost, but the question of more importance is, "Are the methods and system they are using making for them all the money that it is possible to make?" That should be the supreme test. In other words, the best method and the best system is the one that has cut out all waste, reducing the cost to the minimum and netting the greatest possible profit. This in the broad sense is the work of the engineer.

These words and thoughts are extremely applicable to earth excavation. Earthwork and earth structures are among the oldest of all engineering works, yet we are learning new economic facts regarding this branch of engineering every decade. Nearly every engineering problem presents some feature of earth excavation that has to be solved.

The first detail of excavation is how shall the earth be loosened? Some form of the pick and shovel are among the oldest earth working tools that are known to men. These tools were used in prehistoric times. Hence some kind of a pickax was first used by man to loosen earth. To-day we have various styles of picks that are in use. One of these is known as the mattock, and it is of the uses and misuses of this tool that we wish to speak.

There are three kinds of mattocks in use to-day. The first one is known as the grub ax or grubbing hoe. This is used to a greater extent by farmers than it is by dirt movers. It is really a compromise between a pick and a hoe. It has an eye for the handle like a pick, but it only has one end or blade like a hoe, the blade being from 2 to 3 ins. wide. To-day the hoe is not looked upon as a dirt digging tool, but a heavy type of hoe has frequently been used as a digger. During the slave days in some of the southern states the hoe was used extensively to loosen the ground for the planting of cotton and other crops, instead of plows. With a large number of slaves to be kept employed during the mild winter months, it was found more economical to turn the ground with heavy hoes than to use horses and plows. Hoes are still used to dig up weeds and small roots, but for heavy roots that go deep into the ground it is too broad to do the work well, so the grub ax or grubbing hoe is used for this purpose.

This tool is like the mattock in common use among contractors, except the cutter end is left off. This makes the tool much lighter, and also prevents it from being as well balanced as when the cutter end is on it. The grubbing hoe is, as its name implies, meant almost entirely for grubbing, yet if roots are to be cut, it is necessary to have an ax to do this. It will dig dirt in a manner similar to the mattock, but not as well owing to its not being as well balanced. The fact that an ax is needed with the grubbing hoe has given us the mattock that has both the grubbing and cutting ends.

Mattocks are known under two names, the "short cutter mattock" and the "long cutter mattock." Each can be bought of weights varying from about 5 lbs. up to 12 lbs., the difference in the two styles being mostly in the length of the cutting blade. The "short cutter" has a blade about 4 ins. long, while the "long cutter" blade is 6 ins. or more in length. Naturally a greater range of work can be done with the "long cutter," hence it is the one in more common use, and is generally preferred by contractors. When we speak of a mattock it will be of the "long cutter."

The mattock being primarily designed as a grubbing tool, finds its greatest use in that line. A pick should not be used for this purpose. If even small roots are encountered, it will not cut them, but they must be exposed and the end of the pick inserted under them, and then using the pick as a lever they can be either broken or the loose end of the root pried out of the ground. This means that part of the root is still left in the ground to be cut or broken again. With a mattock small roots can be cut by either end of the tool, while the cutter end will cut through larger roots in a manner similar to an ax.

Extremely large roots should not be cut with a mattock, but instead should be exposed by the mattock with the aid of shovel and then cut with an ax. It can be done with a mattock, but not as well or as economically as with an ax.

In digging around roots to expose them, the broad digging blade of a mattock cannot only be used for loosening the dirt, but it can be used in the manner of a hoe to draw out the loosened earth from under the root, or along side of it, or from the small spaces between a mass of roots. A shovel is of little service in such places, as it is unwieldly and but a small quantity of earth can be picked up by it, but if the mattock is used like a hoe the earth can be pulled out so that good work can be done with the shovel.

In digging up stumps the tools needed are a mattock, a shovel and an ax. Most stumps can be blasted cheaper than they can be dug up by hand, and stump pullers will frequently save money over blasting, yet there will always be some grubbing done by hand, just as with innumerable machines for excavating earth there is always some work that needs the pick and shovel. Stump pullers should be used wherever it is possible to do so, but even when they are so used many stubs and roots must be dug up with the mattock, especially when scrapers and elevating graders are used. It is true that many of these smaller roots can be torn up and rooted out by using a rooter plow that is manufactured by the different plow companies, but still some of this work must be done by hand and the mattock should be used for it.

In trimming ground the mattock is much better adapted than the pick. This is so of parking work, as in trimming there is seldom more than an inch or two of earth to be dug and the narrow pick will not cut off as much earth at each stroke as the broader blade of the mattock. In railroad cuts, the pulling down and dressing up of slopes is done better by mattocks than it is by picks. Likewise in cellar and foundation work, where it is necessary to dress down a perpendicular side of a bank to neat dimensions and lines, the mattock does better and more economical work than a pick. Thus for nearly all cases of trimming and dressing the mattock should be the tool used.

For digging, as a rule, the pick should be given the preference. At one blow with a pick a large wedge shaped piece of earth can be loosened from a bank, when the face of the wedge is free, while with a mattock a single blow will not loosen as large an amount of earth, the piece being a truncated wedge, of seldom more than half the altitude of the wedge the pick will loosen, and only about two-thirds of the base. This should always be remembered, as the most important misuse of the mattock is to use it in open cut work for digging.

The mattock can be used to better advantage than a pick for digging in some few materials. This is so of very plastic clays. A pick will make but little more than a hole in material of this kind, and when it is used as a lever, this hole will simply be enlarged, but with a mattock small pieces can be pried out and large pieces can be cut out by the cutting blade. A more economical and satisfactory way of digging this kind of material than with either the mattock or the pick is with a good street spade. One of the editors of this paper increased the output of a gang of men nearly 30 per cent in handling such material in a railroad cut some years ago by substituting spades for mattocks and shovels. All the work was done with one tool, and the loosening or digging was done better and cheaper with the spade.

In swampy and marshy ground the mattock is superior to the pick for digging. This is due to the fact that there are generally roots in such ground, and also because the material is generally clay of more or less plasticity. The comments that have been made regarding grubbing with a mattock show that it is the tool for digging and loosening wherever roots are encountered. It is also true that turf and peat are dug better with a mattock than with a pick.

In digging ditches and trenches a mattock is often needed until the trench is a foot or more deep, as roots are encountered and sometimes old logs and debris, but as soon as this kind of material is gotten rid of, only picks should be used. The cast is greatly increased by using mattocks. The sides can be taken down in trenches with a pick, so that sheeting can be put in place, so the mattock is not even needed for dressing the sides. In open ditches the pick should be used for digging, but when a permanent slope is to be put on the ditch a mattock should be used, although there are several machines that dress up some kinds of ditches cheaper than it can be done by hand.

It has been made evident that the mattock is essentially a grubbing and dressing tool, and is only adapted to economical digging in a few special materials. It may be termed a misuse of the tool to make it do digging in ordinary earth. For earth work a supply of mattocks and picks should always be provided, so that as occasions arise for the use of each they will be on hand and money will not be wasted in making a tool do work for which it is not designed or adapted.

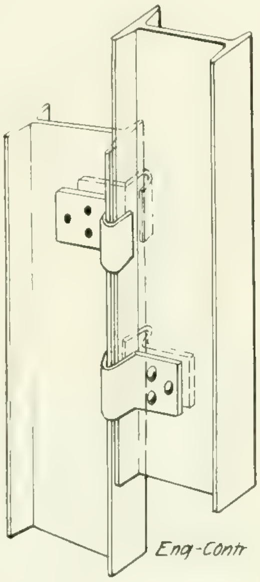
Among the general provisions of the contract for street sprinkling at St. Louis, Mo., is a clause stating that if the contractor shall render any street muddy by reason of excess of water used, or if he shall allow any street to become dusty by reason of failure to sprinkle or to use a sufficient quantity of water, there shall be deducted from the amount payable under the contract the sum of 5 cents for every lineal 50 ft. of such street so rendered muddy or allowed to become dusty. The deduction shall be made from the monthly estimate.

In the construction of new track and for renewals, the steam and street railroads used, in 1906, over one hundred million cross-ties. The average price paid was 48c per tie. Approximately three-fourths of the ties were hewed and one-fourth sawed.

A Large Cofferdam of Steel Sheet Piling

The steel sheet piling shown by the accompanying cut has been used in constructing a cofferdam, 40 x 132 ft., for the subbasement excavation of the Steele-Wedeles Building in Chicago. Besides the main cofferdam an elevator shaft pit and several circular wells for concrete piers have been enclosed by the same piling. The building abuts on the Chicago river at Dearborn street and the piling was driven through quicksand and Chicago clay to a depth of 45 ft. In driving two timbers were lined up on the surface with just enough space between to pass the I-beam piles; these timbers served as guides for alinement. The driving was done with a 4-ton steam hammer and a gang of eight men put down a maximum of 39 piles 45 ft. deep per day.

The construction of the pile is clearly shown by the drawing. The first I-beam is driven without clips, then the second I-beam with a clip at the bottom is locked with the first and driven to a start. The clip is then attached by bolts to the first pile driven as shown, and the driving completed. The third pile is driven like the second and so on. In place of two clips three or more may be used as the length of the pile demands. This pile is patented by George W. Jackson, Inc., Chicago, Ill., who is also the contractor for the foundation, including the cofferdam and shafts described in the opening paragraph.



Jackson Steel Sheet Piling.

The Milan city government has voted to appropriate $2,000 toward the fund which is being raised to complete the survey of the Splugen tunnel route through the northern Alps, by which Milan and Lombardy will be connected by still another direct line with central Europe.

The Chilean government has begun work on double tracking the main railway line from Valparaiso to Santiago, a distance of about 100 miles.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Methods of Constructing Foundations for Lift Bridges with Some Figures on Costs.

The running of the new East Chicago Canal from the inland to its junction with Lake Michigan at Indiana Harbor, Ind., where it connects with the ore unloading slip of the Inland Steel Co.'s plant, makes necessary lift bridges in the tracks of all those railroads which skirt the southern lake shore on their way east. The P. R. R. is farthest from the shore of the lake with two tracks, the L. S. & M. S. with six tracks is next, the B. & O. R. R. is next with two tracks and the C. L. S. & E. R. R. with two tracks is the one closest to Lake Michigan. The average amount of excavation for the piers of these lift bridges is about 5,000 cu. yds. for each two-track lift bridge. The lay-out of the work is shown by Fig. 1.

The work on the Lake Shore & Michigan Southern is three times as large as that of any of the other roads and is the work described here. Since three double-track bridges are to be built side by side on this job, the excavation work is obviously less in amount per double track than is the case with the other three separate jobs which have only one double-track bridge each.

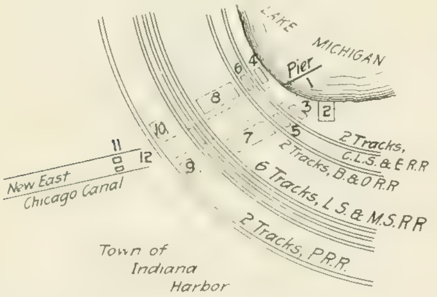


Fig. 1—Layout of Work.

At the beginning of the work the Lake Shore people drove and jetted Wakefield sheet piling of 2 x 12-in. yellow pine 32 ft. long. These were so over-lapped as to make 3 ft. of piling measured horizontally for every foot of periphery around the cofferdam, which is 42 x 105 ft. One 2,000 lb. drop hammer with a gang of 12 men at an average wage of $2.45 per day drove 15 peripherical feet of sheeting per day. This gives a cost of practically $2 per peripherical foot of triple thickness piling 32 ft. long.

Since jetting was employed the piling generally sank under the weight of the hammer and very little driving was needed in this portion of the work. From about the middle of September until the first week in November the excavation work had been carried down 26 ft. and foundation pile driving started. Ten men at $1.60 per day, one hoisting engineer at $3.00 per day and two men at the gondola car, dumping the 1 cu. yd. cylindrical buckets, constituted the gang for this work.

As the work progressed onward through 8 ft. of dry sand, 9 x 18-in. walling pieces with the flat sides against the sheet piles, were run at a depth of 6 ft. below the top of the sheet piling all the way round the cofferdam. Cross bracing of 9 x 18-in. timbers longest dimension vertical were then strung across the cofferdam at intervals of every 15 ft., measuring along the longest dimension and every 14 ft. along its shortest dimension. Two different lengths of these cross pieces were used, namely: 14 and 28 ft., approximately, and as shown by Fig. 2 they were employed alternately or staggered. Vertical posts were set in at the junction of the longitudinal and transverse bracing as shown, and ½ x 4-in. forged angle, each leg 5 ins. long and containing two holes was used in connection with 8-in. lag screws to join the longitudinal or the transverse bracing, as the case may be, to the vertical uprights.

As the excavation was carried down new waling pieces were added at intervals of approximately 5 ft. each until the full depth of 28 ft. was reached. These lower waling pieces, however, were composed of two 9 x 18-in. timbers lagged together and placed with their narrowest dimension against the sheet piling in order to gain additional strength since the earth pressure increases at the lower depths. Beneath those points where the waling pieces and the cross bracing intercepted, vertical 8 x 16-in. timbers were lagged on with the flat side against the sheet piling as shown.

At a depth of about 8 ft. below the surface the excavation became wet and two type B Emerson Junior pumps, with 4-in. suction and 3-in. discharge pipes were hung from the upper timbers. These sufficed for unwatering the excavation down to its lowest level, 25 ft. below the water line, and during the time the foundation piles were being driven. Two other Emerson pumps were used also in the cofferdam for the smaller pier. These only weighed 250 lbs. each. A total of 1,200 piles were driven in the main and minor excavations and 24 men averaging $2.45 per day with one 2,800-lb. and one 2,000-lb. drop hammer in 65-ft. leads, drove an average of 30 piles per day, each pile approximately 45 ft. long. This gives a labor cost for driving of $1.96 per 45 ft. pile.

The method of mounting the pile drivers is shown by Fig. 2. Two chords 9 x 18-ins. each were lagged together with joints staggered and in lengths of approximately 30 ft., so as to make an 18 x 18-in. girder 60 ft. long. Two of these girders spaced about 10 ft. apart rested upon the transverse and vertical cross bracing of the upper tier. Across these two girders were laid two 10-in. wrought iron pipes extra heavy which served as rollers for the hoisting engine which operated the drop.

Since the piles were not driven until the excavation had reached its lowest level there were, therefore, four different tiers of cross bracing which interfered with the lateral movement of the pile driver leads; instead therefore, of lifting the entire 65-ft. leads out of the excavation whenever the progress of the pile driving made it necessary to cross a longitudinal or transverse bracing timber, the following expedient was resorted to: The lower 30 ft. of the pile driver leads was made detachable and by merely taking out eight bolts the hoisting engine lifted this lower section above the upper tier of cross bracing and the engine was pushed over into the next shaftway where the lower section was again dropped into place and the pile driving resumed—a change requiring little over five minutes time to consummate.

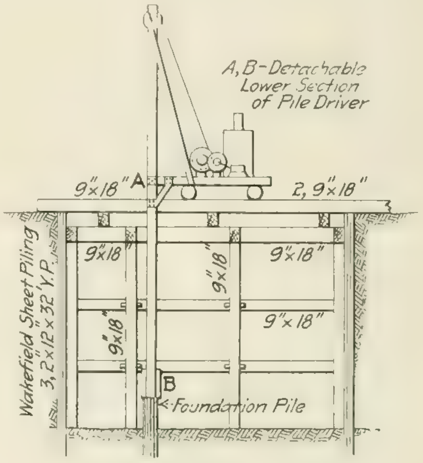

A, B-Detachable Lower Section of Pile Driver
9"x18" A
2, 9"x18"
9"x18"
9"x18"
9"x18"
9"x18"
9"x18"
B
Foundation Pile
Wakefield Sheet Piling 3, 2"x12"x32' Y.P.

Fig. 2—Sketch Showing Method of Mounting Pile Drivers.

The general provisions of the contract for street sprinkling at St. Louis, Mo., provide that the contractor shall have the right to take water free of charge. It also provides that a deduction of $2 shall be made in the monthly estimate for every fire or sprinkling plug which is left wholly or partly open when not in use for filling tank, and $5 for each and every time the contractor uses a plug withdrawn by the street commissioner.

The Metropolitan Water Board of London, England, has abandoned for the present the scheme to bring London's water from Wales, and will ask parliament to authorize the building, at a cost of $8,250,000, of a reservoir in Bourne valley, to be ten square miles in area and capable of impounding 55,000,000,000 gallons.

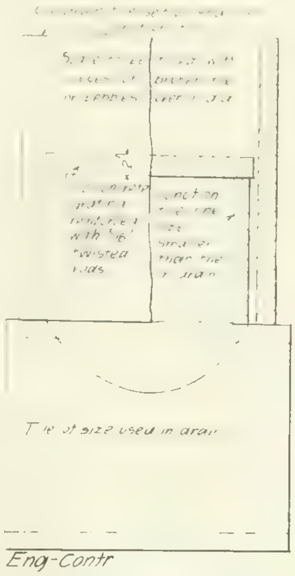
The U. S. dredge boat Henry Fladd, valued at $175,000, was burned to the water's edge at her moorings in Memphis Jan. 11.

Methods and Costs; Some Old; Some New.

Stopping Leak in a Coffer-Dam. \ coffer-dam made of two parallel lines of stone-filled timber cribs, each 20 ft. wide, and an 8 ft. clay middle section, sprung a leak at a point where the water was about 30 ft. deep. The dam was built on a rock bottom, so piles could not be used. Bags of clay and bales of hay were thrown into the break but were washed through like corks. Sheet piling was then driven along the inside of the inner crib, and formed a sufficient obstacle to stop the bags of clay and bales of sand. In this way about one-half of the inflow was stopped. Heavier sheet piling, consisting of 12-in. square timbers, sharpened to a chisel edge at the lower end and shod with iron, were driven to rock between the cribwork and the sheet piling. The clay wall was then loaded with stone to compress it, and the leak was stopped sufficiently so that pumps could handle the inflow. It was desirable, however, to entirely close the break and accordingly an iron rod was driven down through the clay wall until it would go no further. The depth penetrated was compared with the depth to which the timber had been driven and proper notes made concerning any effect upon the muddiness of the leak. The rod was then withdrawn, moved laterally a distance of 8 ins., and again driven to rock. The operation was repeated until one end of the rod went 2½ ft. deeper than at a distance 8 ins. on either side of it. In this manner the crevice in the rock was found, and steps were taken to fill it with clay. This was done by driving an iron pipe into the crevice, filling the pipe with clay and forcing it out by an iron rod acting as a piston and driven down by the pile driver.

Rail Relaying Gang.—At the last annual convention of the Roadmasters' and Maintenance of Way Association a committee report was read on relaying rail and the organization for the work. According to the report 51 men will make a good rail gang for 85 to 100 lb. rails, this gang being made up as follows: 1 foreman, 1 assistant foreman, 12 men on the tongs, 7 men pulling spikes, 6 men adzing, 1 man plugging spike holes, 4 men throwing out old line of rails, 10 men spiking, 5 men bolting, 2 flagmen, 1 tool man, and 1 water man. A gang of this size can lay one mile of track per day on the average railroad. All rails should be laid one at a time, except in a yard where business is too heavy to permit of the use of the tracks. Heavy adzing should, if possible, be done in advance of rail laying.

Tile Drainage Catch Basin.—We illustrate herewith a catch basin which has been used in county drainage work in Iowa. A tile catch basin that reaches the surface of the ground is very liable to be broken by teams or rocks falling on it. This catch basin is buried in gravel which allows surface water to reach it quickly and yet leaves nothing exposed. As will be seen by the drawing, the basin consists of a junction tile a size smaller than the tile in the drain. In this junction tile is placed a grating and on top of this is placed broken tile or pebbles over 1-in in size. Another piece of tile is set on end over this junction tile, and the ditch is refilled with gravel for a distance of 5 ft. on each side of the catch basin. This form of catch basin is used by A. O. Anderson, C. E., of Lake City, Ia., to whom we are indebted for the above information and for the drawing.



Tile Catch Basin.

Putting in Pier Masonry.—The subfoundation for a bridge pier was prepared by driving a cluster of piles and sawing them off at a uniform elevation, level with the river bed, thus preparing the top to receive the grillage. This latter was octagonal in shape and was formed by drift bolting together three courses of timber, the dimensions being somewhat larger than the outside dimensions of the pier it was to receive. The grillage was floated into position over the piles, and confined by guide piles on each of the eight sides. The ring of masonry forming the front face of the pier was then commenced on the grillage, the interior being left hollow. In order to prevent the pier from settling unequally four vertical rods were attached at their upper ends to cross timbers framed to the guide piles and at their lower ends to the grillage. It was not intended to have the rods support any portion of the weight of the pier; they were used to insure its vertical descent. As the grillage with its load sank, the ring of masonry was built higher and the water which came through the ring was kept down by pumping to an extent which should permit the buoyancy of the water to support the pier. As the pier sank under the increased load of the masonry the nuts on the upper ends of the vertical rods were slackened, permitting the rods to be drawn down by the weight of the masonry. After the grillage rested upon the pile foundation prepared for it, the pile interior was built up solid with masonry.

Data on Street Cleaning at St. Louis, Mo.—The street cleaning of St. Louis is done by force account, six day gangs and four night gangs being employed in the work. A gang comprises the following:

5 flushing machines at $6.00	$30.00
4 dirt wagons at $4.50	18.00
6 laborers at $1.50	9.00
1 inspector at $3.00	3.00
Total	$60.00

From 20 to 35 gallons of water are used for each square (100 sq. ft.) of flushing. The average cost to the city per great square (10,000 sq. ft.) for flushing the pavements in the business and resident districts is $1.10, according to data furnished by Mr. Jas. C. Travilla, street commissioner. This estimate is based upon the number of squares flushed per month, without regard to the paving material, or where the streets cleaned are located. It is possible to flush an asphalt pavement in the residential district for $0.75 per great square, while the granite block pavements in the business district, where the delays are caused by traffic, may cost $1.35 per great square. The average cost for machine broom sweeping is about $0.50 per great square, these machines being used on the brick pavements except where the streets are very dirty. The block patrol system of cleaning is also employed. In this, one man is given about five city blocks to clean, the average length of block being 300 ft. With wages at $1.50 and the width of roadway assumed at 36 ft., 5½ great squares are cleaned each day at a cost of $0.28 per great square. The system of street sprinkling aids very much the cleaning of streets by the block system, as all of the paved streets are sprinkled from one to four times per day, the cost thereof being charged as a special tax against the property fronting the street sprinkled, the average rate for the year amounting to about $0.04 per front foot. The total mileage of hard pavements is as follows:

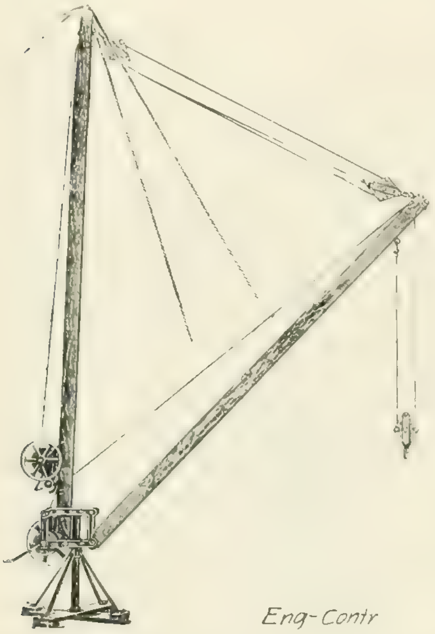
	Miles.
Asphalt	45.42
Bituminous macadam	24.46
Vitrified brick	96.19
Granite blocks	63.48
Wood blocks	2.50
Total	232.05

In addition, 134 miles of improved alleys are cleaned from the appropriation for street cleaning.

A Light Derrick Adaptable for Many Purposes.

The accompanying illustration shows a light and easily handled derrick, which can be used for many purposes. The essential features of this derrick are the ease and rapidity of action in setting up. With it loads up to 600 lbs. can easily be lifted by two men on the fast speed, and 1,500 lbs. can be handled by throwing in a small pinion.

As shown in the cut, the derrick is very simple in construction, having but few parts, namely: (1) Cross base, with center post braced by four steel braces and provided with a cast thimble on which the frame of the machine rests; (2) the frame with gears, drum and brake; (3) mast with necessary guys; (4) boom with necessary cables and blocks; (5) small winch strapped to mast for operating boom, only needed when a load of 1,000 lbs. or more is to be set in place with ease.



Parker Derrick No. 1.

The derrick is especially adapted to building work and will handle concrete blocks, wheelbarrows full of cement, steel beams, stone, timbers, and, in fact, any load up to its guaranteed capacity. It is adaptable to many purposes. For instance, one contractor in building a church used the derrick as a material hoisting machine. He set it up on the floor, and in place of winding the ropes on the drum, let the rope go through the floor. Then by means of a pulley at the bottom he was able to use a horse to do the hoisting and could pick up a wheelbarrow of brick or mortar and set it right on the scaffolding. Another contractor used the derrick as a stump puller and for drawing heavy machinery up inclined planes.

The derrick shown in the cut weighs 450 lbs. complete, the heaviest part weighing 160 lbs., and can be set up ready for business in thirty minutes. Two types of these derricks are made: No. 1, the capacity of which is 1,500 lbs., and No. 4, which has a capacity of 4,000 lbs. The derricks are made by the Parker Hoist and Machine Co., 958 North Francisco avenue, Chicago, Ill.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0536. **Fireproof Tile.**—Concrete Stone & Sand Co., Youngstown, Ohio.

This large 4-page folder illustrates and describes the mold manufactured by the above named firm for making concrete tile. The method of molding the tile is described and results of tests showing crushing strength are given. The product is an interesting one and is worth looking into.

No. 0537. **Tools and Hardware Specialties.**—John Stortz & Son, Philadelphia, Pa.

This company manufactures a large line of tools for plumbers, masons and cement workers. This is a catolog of 146 pages and illustrates and gives prices and sizes for each of the tools made. The line of tools for cement workers and especially for cement sidewalk work is very complete. Special claims are made for the quality of material and workmanship put into these tools.

No. 0538. **Concrete Mixers.**—The Ashland Steel Range & Mfg. Co., Ashland, Ohio.

The mixer described in this 4-page folder is a mixer of the continuous type. The advantages claimed for the continuous type mixer are briefly stated, and the construction and operation of this particular make of mixer are described. The mixer is provided with automatic measuring devices for proportioning the concrete material.

No. 0539. **Solar Ephemeris.**—Keuffel & Esser Co., New York City.

Practically every surveyor is familiar with the annual Solar Ephemeris issued by the above named company. The present edition is even more complete than those of previous years. In addition to the regular tables there are given a number of illustrations and directions for using various attachments to engineering instruments used to do a work where the position of the sun has to be determined. The Ephemeris will be mailed free to anyone requesting it.

No. 0540. **Waterproofing.**—E. J. Winslow & Co., Chicago, Ill.

This set of four pamphlets describes the character and method of using Hydrolithic Coatings for waterproofing concrete and masonry. Views are given of a large number of buildings and other structures which have been waterproofed with this material. Drawings are shown illustrating methods of performing various details of waterproofed work, and there is a complete set of directions for the mixing and application of Hydrolithic waterproof coatings. The complete set of pamphlets covers the subject of this method of waterproofing very thoroughly and is well worth securing by those who have concrete work to do in which protection from water is necessary.

No. 0541. **Star Stettin Waterproof Cement.**—Star Stettin Portland Cement Works, Meacham & Wright Co., 138 Washington St., Chicago, Ill.

The special waterproof cement made at the Star Stettin Portland Cement Works in Germany is known by name at least to nearly all concrete workers. This 4-page circular describes some of the uses to which this cement can be put and gives brief directions for its use. Some records of tests of Star Stettin cement are also given.

No. 0542. **A Large Planing Machine.**—Niles-Bement-Pond Co., New York.

This 18-page pamphlet illustrates and describes completely the large planer recently built by the above named company for use in making armor plate. The planer weighs 422 tons and requires motars with a total of 207 H. P. to operate it. The space between the uprights is 14 ft. and the stroke of the cable is 30 ft. The machine is an impressive example of the magnitude of modern machine tools and those interested in this type of machinery will find the pamphlet interesting to read.

No. 0543. **Nomenclature of Murray Corliss Engines.**—Murray Iron Works, Burlington, Ia.

This 22-page pamphlet contains a character of information which it is not usual to find in trade publications. Each style of Corliss engine made by the above named firm is illustrated by a halftone view, and also by a line drawing on which each part of the engine is designated by its proper name. The drawings include general plans and elevations, details of separate parts and especially complete details of the valve mechanism and cylinders.

Personals.

Mr. Samuel L. Cooper has been reappointed City Engineer of Yonkers, N. Y.

George F. Evans, vice President and General Manager of the Maine Central R. R., died Jan. 10 at Vanceboro, Me., while on a tour of inspection.

Mr. O. H. Crittenden, Resident Engineer of the International & Great Northern R. R., at Palestine, Tex., has been made Consulting Engineer of that road.

Mr. Walter B. Snow, Publicity Engineer, 120 Summer St., Boston, Mass., has been elected President of the Alumni Association of the Massachusetts Institute of Technology.

Mr. Walter S. Morton and Mr. W. W. Burritt have become associated under the firm name of Morton & Burritt, with offices at 2 Rector St., New York, where they will conduct an engineering practice.

Mr. H. S. Rogers, Engineer of Maintenance of Way of the Illinois, Iowa & Minnesota Ry., with headquarters at Rockford, Ill., has resigned to go with another road and the office has been abolished.

Mr. Charles E. Bolling has been elected City Engineer of Richmond, Va., to succeed the late Col. William E. Cutshaw. Mr. Bolling previous to his election as City Engineer was Superintendent of the Water Department.

Mr. E. K. Stewart has been appointed Chief Electrical Engineer on the Calumet & Lac La Belle Traction Co., and will have charge of the construction of the projected electric railway of the company. The headquarters of the company are Red Jacket, Mich.

Messrs. W. T. Manning, George T. Hanchett and W. D. Young have become associated and will engage in practice as Consulting Mechanical, Civil and Electrical Engineers. They will have an office and laboratory in New York, and an office in Baltimore, Md.

Col. Adolph De Haas, a civil engineer engaged in railroad construction in Nicaragua, died recently of malarial rheumatism at Monkey Point. Col. De Haas for a number of years was located at Little Rock, Ark., as engineer for the St. Louis, Iron Mountain & Southern Ry., on the construction of the White River branch.

Mr. Charles V. Weston has been elected President and General Manager of the South Side Elevated R. R. of Chicago, Ill. Mr. Weston was Chief Engineer of the road from 1903 to 1907, when he resigned to become the city's representative on the Board of Supervising Engineers in charge of the reconstruction of the street railway system of Chicago.

Mr. F. K. Rhines, Engineer, has become assistant to the Treasurer and General Manager of The General Fireproofing Co., Youngstown, O., assuming the new position Jan. 1st. Mr. Rhines formerly was engineer with the East Iron & Machine Co., bridge builders, at Lima, O., and more recently has been Chief Engineer and General Manager of the Dixon Engineering & Construction Co., of Toledo.

Mr. F. J. Cole, Mechanical Engineer of the American Locomotive Co., has been appointed Consulting Engineer with headquarters at Schenectady, N. Y. The office of Mechanical Engineer has been abolished and its duties will be included in those of Mr. William Dalton, Chief Engineer. Mr. Carl J. Mellin, Designing Engineer, has also been appointed a Consulting Engineer with headquarters at Schenectady.

Messrs. Myron H. Lewis and Clifford B. Moore, editors of "Waterproofing," have opened offices in the St. James Building, 1133 Broadway, New York, where they will conduct a general Consulting Engineering Business in waterproofing, foundations, hydraulics and reinforced concrete. Special attention will be given to making investigations, reports and tests and to the preparation of plans, estimates and specifications for waterproofing and dampproofing work of every description.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class matter April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:
The Longest Reinforced Concrete Span in the World.........53
CONCRETE SECTION:
Method of Maintaining Line Shafting and Machine Operations in Reconstructing a Factory.........54
The Proposed Henry Hudson Memorial Bridge at New York City......54
EARTH AND ROCK SECTION:
A High Cost for Excavating with Carts.........57
Cost of Casting Earth for Filling in Behind Retaining Wall.........58
Hand Drilling and Plug Drilling......58
Cost of Wheel Scraper Work and Sloping Banks on a Railroad Job...59
GENERAL ARTICLES:
Data on Oiling Park Roadways at Kansas City, Mo.........60
Obstacles to Construction Work in the Arid Regions of the West.........60
A Continuous Blue Printing Machine..61
Some Types of Contractors' Cars.....63
Annual Convention of Illinois Society of Engineers and Surveyors........63
METHODS AND COSTS:
Testing Blasting Caps—Excavation Table for Ditch Work—Preventing Gumbo Slides—Road Construction in Yukon Territory.........62
CATALOGS WORTH HAVING.........64

The Longest Reinforced Concrete Arch Span in the World.

We give considerable space in this issue to a discussion by Mr. Leon S. Moisseiff of the engineering features of the proposed Henry Hudson Memorial Bridge at New York city. Mr. Moisseiff is, we believe, the engineer to whom the computation and design of this structure are chiefly due, and the discussion which we reprint is a report to his superior, the chief engineer of the Department of Bridges of New York city. In this report Mr. Moisseiff advances arguments to show the feasibility of constructing the proposed reinforced concrete arch of 703 ft. clear span. It may be presumed, we take it, that these arguments represent the opinions of the department and are in a large sense official. This being the case, they deserve study and fair consideration from every engineer interested in concrete construction.

The main span of the Henry Hudson Memorial Bridge is a reinforced concrete arch of 703 ft. clear span. This span is nearly 2½ times as long as that of any masonry arch heretofore built; it is nearly twice as long as that of any masonry arch ever designed. There are not many steel arches of longer span. Engineers have naturally received these facts with varying emotions. To some the fact that reinforced concrete construction has reached to such heights of confidence that it has been considered for so great a work overshadows all things else; to others it has appeared that the design strains reinforced concrete into a function that steel would fulfill more easily, and to others it has seemed that the design has not been worked out with a realizing sense of the difficulties of practical construction. A good deal could be written from each of these viewpoints and a good deal has already been written, and it seems to us that much of what has been written is beside the question.

In his report Mr. Moisseiff does not mention why steel was set aside in favor of reinforced concrete as the material from which to construct this bridge. Any engineer can hazard a shrewd guess at the reason, however. It seems to us that this reason or the reason why one long span instead of two shorter ones was adopted or any other reason is not the interesting question in this case. This question is: Can such an unprecedentedly long arch span of reinforced concrete be sucessfully built? Mr. Moisseiff's argument is to the effect that it can be built. We believe that the majority of practical engineers will agree with his conclusions. This has nothing to do, be it remembered, with the question whether or not it might be cheaper and easier or might be better engineering to build something else. These are other questions. Our present question is: Is it impracticable—not impossible but impracticable—to build in this place and under the conditions existing there a reinforced concrete arch of 703 ft. clear span?

Contrary to what some writers seem to think the possibility of using reinforced concrete for unprecedentedly long spans, judged from masonry arch standards, is not a new thought. Ten years ago so eminently practical and shrewd an engineer as Mr. Edwin Thacher, M. Am. Soc. C. E., worked out a tentative design for a 300 ft. span reinforced concrete arch and as a result expressed his confidence in the practicability of similar arches of 500 or 600 ft. spans. We may admit this speculation to mean little or much as we choose, but it certainly frees the engineers responsible for the design of the Henry Hudson bridge from any charge of presumption in designing a 700 ft. span of reinforced concrete. If, moreover, we take the trouble to look abroad we will find at lease one engineer of prominence, Mr. Armand Considere, confidently proposing reinforced concrete for even longer spans.

In all but one respect Mr. Moisseiff's argument in proof of the safety and practicability of his design is convincing. The sufficiency of reinforced concrete to make a strong and enduring bridge when once the material is in place and has come to its strength is open to small doubt. It is the task of holding the material in place until it has gained its strength that presents doubtful possibilities. On this point Mr. Moisseiff's discussion is unfortunately brief. It is stated merely that the arch centering will be designed by the engineers of the Department of Bridges and will form a part of the contract for construction. In a word, the city is to shoulder the cost of centering and so ensure its design and construction according to its own ideas of sufficiency and safety. This is perhaps the very best plan that could be devised for the conditions, but it does not help to explain the really doubtful point which is how to design and build a centering which will endure the enormous task that will be put upon it. It is safe to say that engineers will watch with unusual interest for the publication of the proposed centering plans.

The Henry Hudson Memorial Bridge is chiefly a task of engineering construction and it is for this reason that we have given a statement of its main features in this issue. The arch is one of unprecedented magnitude and its constructional problems are correspondingly large. We believe that they will be successfully solved. It is, as we have said above, entirely another question whether it was the best engineering to design the bridge as it has been designed and to use the material that has been chosen.

At the coming session of the Ohio legislature a bill is to be introduced to authorize cities of the state to build union depots and terminal stations.

The natives of Shansi Province, China, have obtained permission from the Peking government for the construction of a line from Tatung to Puchow, to be called the Tung-pu line, to be built with only Chinese money, with Ho Fu-fang, formerly provincial treasurer of Kansu, as director. The line will pass through the Hsuan-hua prefectural city, and connect with the Peking-Kalgan railway. The length is to be a little more than 700 miles.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

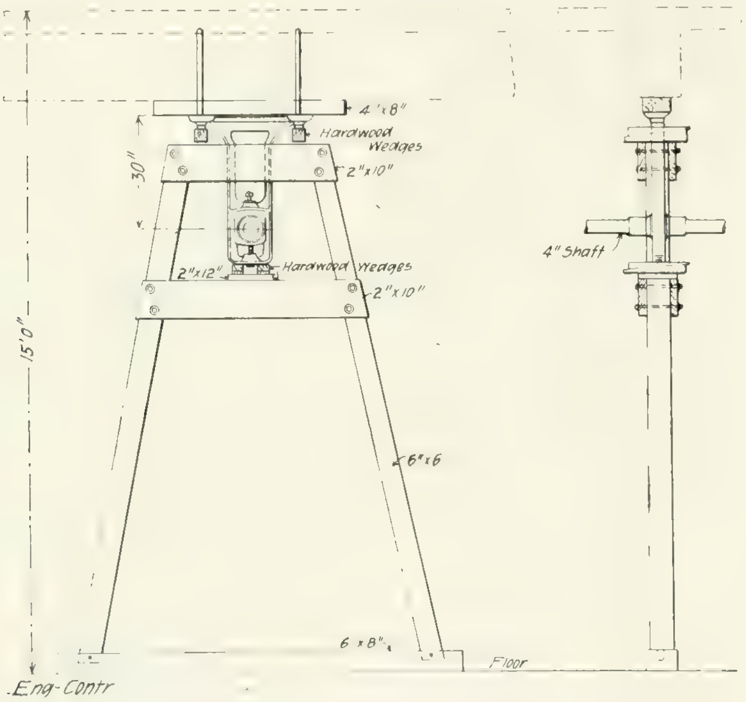
Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Method of Maintaining Line Shafting and Machine Operations in Reconstructing a Factory.

The accompanying sketch shows the method adopted to support the line shafting and thus keep the machine going while replacing an old factory building with a new structure. The original building was 65x85 ft. in plan, and one story high. It was part of the plant of the Pantasote Leather Co., of Passaic, N. J., and contained the heavy machinery for embossing and surface finishing the pantasote. The new building had three times the ground area of the old one and was two stories high; it was built around and over the old building, which it entirely effaced, except for the machinery. The contractor was given the privilege of shutting down the machinery during Thursday, Friday and Saturday, and this period, with the following Sunday gave him four days uninterrupted control of the mill. During this short period he sunk six column piers 6½ ft. square and 14 ft. deep within the old building area and placed the staging to support the line shafting. The piers were constructed of concrete by excavating inside of sheeting. The feature of principal interest is the method of carrying the shafting which is shown by the sketch. A bent or horse of timbers was built under each hanger as shown and then the hangers were detached from their original beam supports. After the old beams had been removed the hangers were capped by 4x8 in. pads and the hanger bolt set as shown. The dotted lines show how the new reinforced concrete slab and girder floor was substituted for the temporary supports.

The contractors for the work were Salmond Brothers Co., Arlington, N. J., who completed the new building, 68x140 ft. in 80 days.



Sketch Showing Method of Supporting Line Shafting During Reconstruction of a Shop Building.

The hardwood lumber cut in 1899 was 8,634,021 thousand feet; in 1906 it was 7,315,491 thousand feet, a decrease of 15.3 per cent.

Kansas City, Mexico & Orient R. R. has applied to the Mexican government for a concession to improve the natural harbor of Topolobampo, which is to be the terminal of the road. It is estimated that about $5,876,000 gold will be spent upon the work, which is to include the construction of a terminal yard and six large wharves.

The Proposed Henry Hudson Memorial Bridge at New York City.

The largest span arch bridge in the world built of other material than steel is the proposed concrete arch of 703 ft. clear opening for the main span of the Henry Hudson Memorial Bridge at New York City. The magnitude of this arch and consequently of the problems in design and construction which must be solved in carrying it to completion make a concise summary of the plans of interest. This summary is given for the first time and officially in a report to the Chief Engineer, Department of Bridges, New York City, by Mr. Leon S. Moisseiff, Engineer in Charge, and we publish it here:

The proposed Henry Hudson Memorial Bridge is a concrete bridge of a total length of about 2,840 ft. It consists mainly of seven circular arches of about 108 ft. clear span each, with corresponding piers, and one main arch of 703 ft. clear span between skewbacks, flanked by two monumental piers of about 108 ft. width and 180 ft. height. The approaches are designed to be of concrete masonry reinforced by embedded steel wherever required, the piers being faced with natural stone.

The bridge is designed with an upper and lower deck providing for surface and subway traffic. The upper deck has a clear width of 80 ft. between balustrades, occupied by a 50-ft. roadway and two sidewalks of 15 ft. each. The lower deck is 70 ft. wide from outside to outside of walls and about 65 ft. on the inside. It is occupied by four railroad tracks and has sufficient space for pipe galleries and the like. The subway tracks on the main span are supported by steel beams and posts resting in turn on the secondary or relieving arches and on the vertical piers designed to be of reinforced concrete.

The provision for the subway tracks will, undoubtedly, prove of great ultimate value to the city, as it provides both local and express tracks at small additional cost. But the utilization of these tracks immediately on the completion of the bridge may not be expected. The location of the bridge, near the most northwestern point of Manhattan Island, is not likely to require and warrant rapid transit transportation before the next ten years. Several years will thus elapse after the completion of the bridge before the subway tracks will be required. Considering this situation, it will be in the interest of good economy not to install the tracks nor to put the steel supports in position before the time requiring their use. It is therefore intended to provide, for the present, the footings for the posts and the means for ready connection with the structure, and to leave the fabrication and construction of the track beams and posts for future time. This is stated here because it has, as will be seen later, some bearing on the strength of the structure when first put in operation.

The design of the approaches, as laid

out, conforms with standard engineering practice, and their construction offers no special difficulties and requires only the attention and execution which should be bestowed on engineering works of this character. They need not be considered here further.

It is in the planning and building of the main span arch that the engineering problems to be solved and the difficulties to be overcome are centered. The clear span of the great arch is about 703 ft. between skewbacks and it has a greatest vertical clearance above the mean high water datum of 183 ft. Expressing it in a more technical way, the span center to center of skewbacks is 725 ft. and the rise, center to center, is 177 ft., or about one-fourth of the span. The longest span of any built masonry arch is that of the bridge over the Syra Valley at Plauen, Germany. It has a span of 295 ft. and a rise of 56 ft. or less than one-fifth of the span. It is built of hard slate. The longest span arch in this country is the Walnut Lane bridge in Philadelphia. It has a span of 233 ft. and is built of concrete without metal reinforcements. About five years ago at a prize competition for plans for a bridge over the Neckar River at Mannheim, Germany, the prize was awarded to an arch bridge with a main span of 365 ft. and a rise of one-twelfth of the span. The material proposed was brick. Because of conditions independent of the engineering problem, the bridge was not built of masonry.

It may be well to state here that the upper Niagara steel arch has a span of 840 ft. center to center of hinges and that the plans for the connecting railroad bridge at Hell Gate call for a steel arch of 1,000 ft. span.

Thus the span of the Henry Hudson Memorial Bridge, while not the longest arch, by far exceeds that of any built or proposed masonry arch. To arrive, however, at a correct basis for comparison, it should be considered that while the span of an arch apparently determines its position in the hierarchy of engineering achievements it is the ratio of the rise to the span that is determining. But the dimension really most characteristic of the boldness of an arch is the radius of curvature at the crown. It has also the advantage of furnishing a means for ready comparison. Thus the Plauen arch has a radius at the crown of 344 ft. and the above mentioned prize design for a Neckar bridge a radius of 558 ft. The radius at the crown of the Hudson Memorial arch is 489 ft., or less than that of the proposed Neckar bridge. It means that the Neckar arch with a span of only 365 ft. will strain the material of the arch rib more than that of the Hudson Memorial Bridge with twice that span. This general conclusion is verified by the comparison of the stresses as determined by careful computations.

The above discussion tends to show that while the Henry Hudson Memorial arch by far exceeds in magnitude any masonry arch in existence, its general proportions have been so chosen as to bring the resulting conditions within the limits of modern engineering practice.

There remains, then, to consider the main factors and physical conditions entering into the construction of a structure of like magnitude. These will be discussed in the following under several headings.

Foundations.—No other engineering structure is as much dependent on the stability and immovability of its foundations as the fixed arch. Even a relatively very small displacement may cause considerable strains in the arch ribs. For a reinforced concrete arch of the dimensions of the main arch of the Henry Hudson Memorial Bridge an immovable, incompressible and imperishable foundation is a prerequisite.

The geological conditions of the site selected for the bridge are quite well known, Manhattan Island and its adjacent territory having been made a subject of study by many geologists. The deep diamond drill borings made by the Department of Bridges, some of which went down to more than 138 ft. below the water level, affirm the information supplied by the former.

The south or Manhattan side of the bridge site is covered with "thin till with numerous rock exposures." The underlying rock is a hard rock known as Hudson schist. It is a sedimentary rock of the Silurian period and is essentially a mica schist consisting of biotite and quartz. It covers the greater part of Manhattan Island.

The surface condition on the north or Bronx side is described as a "till with occasional small rock exposures." The underlying rock here is known as Fordham gneiss. It is an ancient crystalline rock of the Pre-Cambrian period and consists of a gray banded gneiss of orthoclase, quartz and biotite. It begins at Spuyten Duyvil and extends far up the Hudson River.

On both sides the rock slopes rapidly upward to a greatest elevation of 200 ft. above mean high water. The foundations for the main arch are practically all on dry land with the hard rock on the average to fit below mean high water. It is intended to fix the bottom of the foundation at a level of 20 ft. below datum. The abutments, which will be of concrete, will thus rest on the hard rock and also abut against a wall of the same material. The pressure on the foundation is far below its bearing resistance, and to displace the abutments the rocky mountains behind them would have to be moved. The foundations are thus admirably adapted for their purpose and will furnish an absolutely immovable abutment in accordance with the requirements of rigid theory.

Methods of Computation.—In considering the methods of computation used it should be stated here that the construction of the upper and lower decks and of the secondary arches and vertical piers offers no theoretical or practical difficulties which should deserve special consideration. The following discussion refers, therefore, mainly to the great arched rib.

In deciding on the methods of computation to be used and on the degree of accuracy to be obtained, the consideration of the magnitude of the structure has exerted a determining influence. The most accurate available theory is applied; the assumptions it is based on have been scrutinized; simplifications generally made have been evaluated numerically as to their degree of accuracy. The computations are checked by as widely independent methods as physical facts will permit. The most modern procedures of engineering science are resorted to in determining the stresses at every section of the arch. Instead of the common practice of finding the stresses for certain assumed positions only of the moving load, the position of the moving load causing the greatest stress in any section of the rib is determined, and even the loading causing the greatest strain in upper and lower faces has been found. This more accurate method, of course, shows stresses in excess of those determined by the common procedure.

It is realized that the importance of the structure requires that all possible causes of stress in the arch be foreseen and provided for. Not only is, therefore, the effect of a change of temperature within reasonable limits computed but even that of the possible shrinkage of the concrete after the rib has been swung free of its falsework. The stresses caused in the arch by its greatest distortion from the original curve are also included in the resulting total. This again is not done in common practice.

Provision for the future is made by the assumption of high moving loads for both the upper and lower decks. The total moving load the arch is computed for is 15,000 lbs. per linear foot of bridge. Compared with the moving load assumed for the Manhattan or Blackwell's Island Bridges, which are designed for the heaviest loads as yet provided in long-span bridges, the equivalent moving load for the Henry Hudson Memorial Bridge would be 14,000 lbs. per linear foot for congested load and 7,000 lbs. for working load.

Thus, it may be stated, all possible effects on the arch are considered and will be provided for as far as the state of engineering science and the physical character of the material used will permit.

Material Used and Stresses Allowed for It.—As stated above, the materials of the main arch are to be concrete and steel. The arch is to be formed of a solid rib of concrete 70 ft. wide, 15 ft. thick at the crown and gradually increasing to a thickness of 28 ft. at the skewbacks. Embedded in the concrete are 48 rectangular units of four 8x8-in. angles, each laced on all sides. They are arranged in twelve vertical rows or frames which are thoroughly connected, both vertically and horizontally, to each other by bracing, forming a huge steel cage of great rigidity. The steel members of the vertical piers are riveted to the steel frames, securing positive connection for the part of the structure above the rib. The steel units bear with suitable footings directly on the rock and are anchored to it. The distribution of the steel in the concrete is uniform throughout its mass, completely supporting all its parts.

The embedded steel performs two functions: it first carries a certain portion of the load determined by the relative elasticity of the concrete and the steel, and secondly, it enables the concrete to act as a homogeneous mass. The method of reinforcing by box-like units also bands the concrete, furnishing to it a lateral restraint, the great value of which in resisting compressive strains has come to be universally appreciated in recent years. It may well be stated here that the material of the rib will be called on to resist compressive stresses only and that under no conditions can any tensile stresses be induced.

Little need be said as to the quality of the steel required. A good structural steel satisfying the standard specifications of the Department of Bridges will be all that is required.

The concrete, on the contrary, deserves special consideration. The strength of concrete varies with the proportions and qualities of the constituent materials. It is intended to specify for the main structure a concrete at least as rich as one part of Portland cement to six of sand and broken stone properly balanced, which should develop an average compressive resistance of 3,000 lbs. per square inch on a 12-in. cube 30 days old with a least resistance of 2,700 lbs. per square inch. Since a least increase in strength of 10 per cent can be counted on in two months, this would insure an average compressive resistance of 3,300 lbs. per square inch with a minimum of 3,000 lbs. at the end of three months. The method of specifying a concrete of a certain compressive resistance in addition to the usual specifications for the cement, sand and stone, has been approved and recommended by several foreign engineering societies and committees, and is in use in the best European and American practice. It should be applied in the case of the Henry Hudson Memorial Bridge.

Experiments conducted on the effect of age upon the increase in tensile strength of mortar, by Dyckerhoff, for the German Association of Portland Cement Manufacturers, gave the results in the following table:

Time.	1:1 Mortar.	1:2 Mortar.	1:3 Mortar.
4 weeks	Initial	Initial	Intial
13 weeks	51	44	48
26 weeks	53	47	51
1 year	66	60	56
2 years	131	108	118
3 years	125	110	98
4 years	131	124	141
5 years	152	142	148

The increase in the strength of concrete with age is not as rapid in the early months as it is in mortar, but is more gradually distributed through the first year.

Numerous tests on 12-in. concrete cubes were made at the United States Arsenal at Watertown, Mass., with cements of the better brands, in the proportions of one part of cement to two parts of sand and four parts of broken stone, developed a compressive resistance of 3,000 to 3,600 lbs. per square inch at the age of three months.

An experimental arch was built in 1896 at Stuttgart, Germany, of a span of 65.6 ft. and observed under various loads and temperatures during five years. It was made of a concrete of one part of Portland cement and 7½ parts of broken limestone, using the product of the crusher to take the place of the sand. Test specimens of this concrete two years old developed a compressive resistance of 7,260 lbs. per square inch. Blocks cut out of the arch after failure and probably somewhat impaired in strength by the shock of the collapse developed at the age of five years 6,615 lbs. per square inch or 10 per cent less than the test specimens.

The concrete of the Munderking arch was of the proportions of one part of cement to 2½ parts of sand and five of broken stone. At the age of 28 days it developed a compressive resistance of 3,615 lbs. per square inch which at the age of 152 days increased to 4,720 lbs. At the age of two years and eight months it had attained a resistance of 7,130 lbs. per square inch on the specimen and 10 per cent less on the concrete in the structure. The concrete of the viaduct over the Chemnitz Valley was of the proportions of 1:4:4:½. It developed at the age of 28 days a compressive resistance of 3,070 lbs., and at the age of 90 days of 3,770 lbs. per square inch. The concrete of the Exhibition Bridge at Duesseldorf was of the proportions of 1:4:4. It developed at the age of 28 days a compressive resistance of 3,610 lbs., and at the age of 90 days of 3,940 lbs. per square inch.

All of the above data are for concrete not reinforced by steel. The additional assistance furnished by the embedded steel in enhancing the homogeneity and creating a lateral restraint will be so much additional margin of strength. To determine the relative increase in strength due to the latter and also to demonstrate the degree of the co-operation of the two materials a short series of tests is about to be made by the Department.

Unit Stresses in Arch-Rib.—The compressive stress on the steel embedded in the concrete will not be allowed to exceed 20,000 lbs. per square inch, allowing for all possible causes of stress. This is perfectly safe for a material of an elastic limit of 30,000 lbs. per square inch, thoroughly braced and fully embedded.

The greatest stress to be allowed on the concrete in compression due to a combination of all of the causes enumerated in the above discussion on methods of computation has been fixed at 750 lbs. per square inch. This is one-fourth of the least strength of the concrete at the age of three months. Compared to the common methods of computation the equivalent stress would be not more than 600 lbs.

The French Government Commission on Reinforced Concrete, which completed its labors about a year ago, has recommended that "the limit of compressive stress for reinforced concrete to be allowed in computation shall not exceed two-sevenths of the crushing strength of plain concrete of the same proportions and at the age of 90 days." This would allow for a concrete of 3,000 lbs. compressive resistance, a stress of 860 lbs. per square inch.

A noted German engineer, Mr. Leibbrand, who has built many concrete bridges, says: "The more reliable determination of stresses properly allows the use of higher working stresses. For the very best concrete up to 1,030 lbs. per square inch in compression may be allowed."

The rib will be erected on falsework and the centers will not be struck until four months after the completion of the ring. Thus the least age of the concrete when first strained will be four months. The greatest stress caused at any point of the arch-rib when sprung freely off the falsework and only supporting its own weight will be 315 lbs. per square inch. Including temperature changes the stress may reach 350 lbs. per square inch.

The building of the vertical piers and secondary arches will then begin on top of the arch-rib. When the whole bridge, including paving and balustrades, will be completed, but without the subway tracks and their supports, the greatest stress in the concrete of the rib will be 535 lbs. per square inch, due to the fixed load. This cannot be done before a year's time from the date of the completion of the rib.

The total moving load on the upper deck will, in its position causing the greatest stress, bring the total compression up to 570 lbs. per square inch. The effects of a change of temperature, shrinking of the concrete and distortion of the curve will increase this stress to 670 lbs. per square inch. At least a year and a half will be required with the utmost speed of construction from the date of completing the rib to the opening of the bridge for traffic. Before that age of one and one-half years the concrete in the rib will have an ultimate compressive resistance of at least 4,500 lbs. per square inch, or 6.7 times the allowed unit stress.

Finally, when the subway tracks will be installed and trains be operated on the bridge the worst combination of all causes will induce a stress not exceeding 750 lbs. per square inch at any point of the rib. The concrete at that time should have reached a compressive resistance of at least 6,000 lbs. per square inch or three times the allowed unit stress.

It should be noted here that the greatest unit stress in the rib is not one due to direct compression only but represents a sum due both to direct and bending stresses. The resistance of concrete to such combined stress is 10 to 20 per cent higher than to direct stress only.

The above discussion leads to the conclusion that, in view of the consideration given to all possible effects on the structure and the time required before the application of the full load, the adopted greatest compressive strain of 750 lbs. per square inch on the concrete in the rib is well within the limits of safe construction.

Erection and Inspection.—The methods of erection to be followed in building the arch-rib, although generally planned, have not yet been worked out in detail. However, it may be stated that the arch will be erected on falsework resting in the river bed and thoroughly braced. Adjustments will be provided for all possible requirements during construction.

The proper design of the falsework is of great importance and it will be designed and detailed by the Department and will form a part of the contract for building the arch instead of being left to the contractor under the general approval only of the Department. It will be far better not to leave to the contractor to economize on the falsework or its careful design, but that the city pay for it the same as for any permanent part of the structure. Any improvements suggested by the experience of the contractor can always be incorporated afterwards.

After the completion of the arch-rib, it will be kept on the falsework for at least four months before striking the centers. During all this time the whole of the rib will be kept wet by a sprinkling system and be protected from the sun.

The inspection, including the testing of the materials, should be most thorough. A cement and concrete testing laboratory should be established on the building grounds in charge of a competent testing engineer. A testing machine of at least 500 tons capacity will be required for the work.

In addition to the usual experienced inspectors of masonry a corps of young graduate engineers should be employed to watch the work, all well organized under an engineer who should thoroughly understand all sides of the problem and the importance of every part thereof. A sufficient number of inspectors should be employed to insure the constant inspection of the whole job.

Concluding it may be stated that with careful design, careful selection of materials, thorough inspection and conscientious execution there is no reason why the construction of the Henry Hudson Memorial Bridge should not be brought to successful completion.

The average price of electrolytic copper at New York in 1906 was 19.30 cts per lb. The average price for Lake copper was 19.55 cts., and for casting copper 19.1 cts.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

A High Cost for Excavation with Carts.

The systematizing of work, if done properly, means the reduction of cost of doing the work. If one detail is wrong, it means that the cost of many other details will be excessive and the total cost more than likely to be higher than it should be. An example of this kind is given in Engineering-Contracting for Sept. 18, 1907, page 170, and we are able to give another here. The work in question was done by a contractor, but one of the editors of this paper kept cost records on the job.

The job was one of earth excavation done several years ago in the construction of a railroad. A cut was taken out with carts, which were loaded by men using short handled shovels. The work was done in the late fall and early winter, when a fair amount of rain fell, but snow falls did not occur. At night the ground froze to a depth of a few inches, and was generally thawed out by the sun during the day. This made the runway muddy and made some of the shoveling harder. The material was red clay, that readily absorbed water. The average length of the haul was 900 ft.

The earth was loosened by picks, two pickers keeping three shovels going. Three men shoveled into a cart, two carts being loaded at one time. Four carts were used, one driver attending to two carts, which he took to the dump together. One man on the dump, with the aid of the driver dumped the carts.

The wages paid for a 10-hour day were as follows:

Foreman	$3.50
Laborers	1.50
Water boy	1.00
2 carts and 1 driver	4.50

The cost per cubic yard of doing the work was:

Foreman	$0.050
Picking	0.080
Shoveling	0.130
Dumping	0.021
Water boy	0.014
Hauling	0.110
Total	$0.405

The output of this gang per day was 70 cu yds. This means a high cost, as a greater yardage should have been excavated. The pickers loosened about 18 cu. yds. per man day, while about 11 cu. yds. per man day were shoveled. The man on the dump took care of 70 cu. yds. per day. A careful analysis of this and a comparison of costs of similar work*, show that the cost of hauling is a little low, while the other costs are all high. This would naturally lead one to the conclusion that there were not enough carts to make this length of haul and this was the case.

As the foreman was an experienced one, and he realized that he was short of carts, he did all he could to keep them going continually and loaded them as heavily as the ground over which he had to haul would permit. The result was that he worked the carts harder than they are ordinarily worked, as will be noticed from the cost of hauling, which was 11 cts. for a distance of 900 ft. With the wages given above, the cost of hauling per 100 ft. with carts would be about 1 ct., and adding to this the lost team time the total cost should have been for a 900 ft. haul about 12 or 13 cts., while the cost, as stated, actually was 11 cts. That the foreman did his work well is evident from the fact that with a lack of carts that was bound to make his men idle at times waiting for the carts to come back from the dump, he got an output of about 11 cu. yds. from his shovelmen per day.

If two more carts had been used, the shovelers could no doubt have loaded 14 cu. yds. to the man, and instead of using only three men loading to the carts four men could have been employed. This would have made the output per day 112 cu. yds. instead of 70. The cost per cubic yard would have figured out for a day's expenses as follows:

Foreman	$0.031
Picking	0.053
Shoveling	0.107
Dumping	0.013
Water boy	0.009
Hauling	0.120
Total	$0.333

A comparison of this estimated cost shows at once that by increasing the number of carts, which makes the cost of hauling a little greater, the other detail costs are so materially decreased, that a saving on the total cost of nearly 20 per cent is effected. With the material that had to be excavated, a man could readily loosen with a pick, by caving in a bank, from 25 to 30 cu. yds. per day, and a man could load into a cart with a shovel 14 cu. yds. The dumpman could easily have cared for the 112 cu. yds. that were sent to the dump.

The contractor realized that he needed additional carts in this cut, but he had all his own teams at work and had hired all he could find, and would gladly have hired others if it had been possible.

---

*See Gillette's "Earth Work and Its Cost," page 39

The costs as given illustrated in a striking manner how one detail of a job that is not properly managed can materially increase the cost of all the other details and that of the whole job and yet that particular cost may be low. Such facts can only be learnt by keeping detail cost data and then carefully analyzing them.

Cost of Casting Earth for Filling in Behind Retaining Wall.

Several years ago some earth had to be cast behind a low retaining wall that was being built under the direction of one of the editors of this journal. The wall had been built through a tidewater marsh, to retain an embankment that was to be made in filling in the marsh. It was feared that the winter storms might injure the wall, inasmuch as the material was not to be placed in the embankment until the next summer. It was accordingly decided to cast up behind the wall some material from the swamp, so as to strengthen the wall, a thin reinforced concrete one, against the action of the waves. A bank of earth was accordingly filled in behind the wall.

The work was done by company forces, the foreman being paid $2.50 per day of ten hours, and men $1.50. The material was a heavy black clay with a large amount of vegetable matter in it, and very wet. The men did not have to stand in the water, except in a few places, but their shovels were frequently submerged. The soil was excavated to a depth of from 12 to 18 ins., and at high tide there was always water in the holes that were being dug. Most of the material was spaded, but where roots and similar material were encountered, mattocks were used to loosen it. The earth was cast from 5 to 10 ft., and the bank was made about 4 ft. high. The work was hard and difficult, and naturally went slow. The material stuck to the shovels, and the water dissolved the clay causing a man to make several attempts to get a fair shovelful when he was shoveling where there was water.

About 16 men worked under a foreman. The work was done in the early part of the winter. In all 522 cu. yds. of excavation, place measurement, was made. The cost was:

Foreman, 9 days at $2.50	$ 22.50
Men, 158 days at $1.50	237.00
Total	$259.50

This gives a cost per cubic yard of the following:

Foreman	$0.043
Men	0.454
Total	$0.497

This meant that one man loosened and shoveled in a day about 3 1-3 cu. yds. This is a small amount of material for a man to handle in a day, and would make this wet and heavy material rank with much harder materials in cost of excavation.

Hand Drilling and Plug Drilling.

Hand drilling is used quite extensively in quarrying stone, and occasionally this method of breaking up stone has to be used in rock excavation, where blocks of stone have to be split up or pieces broken from ledges and the use of explosives is prohibited.

The method of breaking stones in this manner is known as "plug and feather" work. Small holes are drilled in a row and two feathers, two pieces of half round iron, are placed in each hole. Then a wedge shape piece of iron, known as "the plug," is driven down between the two feathers. By driving the plugs carefully and bringing the same tension to bear on each plug the stone can be broken along the line of the holes.

The rapidity of this work is dependent upon the drilling of the holes. In some rocks, as sandstone, the holes can be spaced at a greater distance than in granites of uneven texture. They are also easier to drill. When these holes are drilled by men using a hammer and drill the work is called hand drilling. These drills are made a foot or more long, usually 15 or 18 inches, and are made of ¾ in. or 1 in. octagonal steel, which is drawn down at one end and shaped into ⅝ in. bit. With such a drill the hole is made ⅝ in. in diameter.

The holes are seldom made less than 2½ ins. in depth, but are usually 3 ins., as most rocks will split easier and better with a 3 in. hole than with a depth of 2½ ins. The holes are drilled dry, that is, without the use of water, and an expert hand driller learns to flirt the dust out of the hole with his drill until the hole gets 2 ins. or more in depth. When the hole can't be kept clear of dust with the drill an iron spoon is used. A man sits on the stone to be drilled and drills 3 or 4 holes without moving.

Some short time observations of hand drilling in granite will be of interest. Two men working side by side drilled holes ⅝ in. diameter and 3 ins. deep in 5 minutes, each man drilling a hole in this time. One minute was consumed in changing from the old hole to the new, until 4 holes were drilled, when 2 minutes were lost in the men changing their seats. Thus in an hour about 9 holes were drilled by each man. This was done upon several occasions, the men not knowing that they were being timed. In a 10 hour day 90 holes could not be done, as two or three times each day the men lost from 10 to 15 minutes upon each occasion, in marking out holes that had to be drilled. The wedging and breaking was done by another man.

The same men, in granite, drilled ⅝ in. diameter holes 2½ ins. deep in 3 minutes. The decided difference in the time is readily understood when it is remembered that the spoon for cleaning the dust from the hole has to be used oftener in the 3 in. hole than it does with the 2½ in. hole. About the same time was lost in changing from holes, thus 12 holes were done in an hour, which means that by reducing the holes in depth one-sixth one-third more holes can be drilled. It would have paid to have reduced the depth in this rock, but for the fact that the shallower holes did not break the rock well, while the 3 in. hole did break them evenly; hence the 3 in. hole was used, as it was considered the cheaper and more satisfactory.

To show the rapidity a man can drill a ⅝ in. hole, an expert hand driller, in a spurt, drilled a hole 2½ ins. deep in 2 minutes, or he could drill 2 holes in 2 minutes; then he was compelled to rest. He did this as a test upon several occasions.

When these holes are drilled by a hand drill driven by compressed air the work is called plug drilling. When the work is of such a nature that it is economical to install and operate a power plant for such drilling it should be done, as much more work can be done with plug drills than hand drillers can do. The holes can also be made deeper, which will mean that the rock will break much better. Some short time records of drilling with plug drills will admit of comparison with the data just given on hand drilling.

In granite in the quarries at Barre, Vermont, a Sullivan foot hole drill, class D 19, using hollow drill bits and weighing 30 pounds, manufactured by the Sullivan Machinery Co., of Chicago, was used in drilling holes and timed in the work. The diameter of the cylinder of this drill is 1¼ in., and it used 25 cubic feet of air per minute at 100 lbs. pressure. This drill can be used in drilling holes up to 1⅝ ins. diameter and 4 ft. deep.

Air is admitted by a push handle throttle, which is opened when the runner presses the drill against the rock, and closed when this pressure is relieved. The hole is cleaned by the exhaust air, which passes through the drill steel, and is kept true and round by rotating the steel with a handwrench.

This plug drill made a record of drilling a number of holes 12 ins. deep and 1¼ ins. in diameter, in an average time of 1 min. 45 sec. The best time for a single hole was 1 min. and 30 sec.

Upon an another occasion in the same granite quarries a Sullivan plug drill, class D 15¼, drilled several holes ⅝ in. in diameter. One of these, 5¼ ins. deep, required 15 seconds to drill, while another 4⅝ ins. deep was drilled in 10 seconds. The best time between holes would not be as great, as when all the work was done by hand, hence one man with a plug drill would do as much work as 2 or 3 men hand drilling. It is useless to comment on this comparison of work.

Cost of Wheel Scraper Work and Sloping Banks on a Railroad Job.

The most economical method of handling work can only be determined by keeping records of the cost of all details, and by trying numerous methods. Then by a careful analysis of these records the method that gives the best results can be determined. This is illustrated by the example of cost of some wheel scraper work given below.

The work was done on a railroad, in one cut, the material being hauled two ways. In the cut there were 2,453 cu. yds., and 1,320 cu. yds. were hauled one way to an embankment, the average haul being 260 ft., making a run of about 620 ft. for a trip to the dump and back. A four-horse plow team with two men to work it was used to loosen the earth, and a snatch team of two horses and a driver was used. Two men manipulated the bar and catch in loading the scrapers. One man did the dumping. The cost of this was:

Foreman, 7½ days at $3.00	$ 22.50
Scrapers, 38 days at $4.75	180.50
Plowing, 7½ days at $9.20	69.00
Snatching, 7½ days at $4.75	35.62
Loading, 15 days at $1.60	24.00
Dumping, 7½ days at $1.50	11.25
Waterboy, 7½ days at $1.00	7.50
Men, 2 days at $1.50	3.00
Total	$353.37

The two men listed were engaged in cutting down the slopes and dressing them. The cost per cubic yard for each item was as follows:

Foreman	$0.017
Scrapers	0.137
Plowing	0.052
Snatching	0.027
Loading	0.018
Dumping	0.008
Water boy	0.006
Sloping	0.002
Total	$0.267

Each scraper team traveled about 12 miles per day. The scrapers were Nos. 2½ and held 1-3 cu. yd. place measurement. The average yardage moved per scraper-day was 34, while the average per team worked was 21.

From the other end of the cut 1,133 cu. yds. were excavated, and hauled an average distance of 400 ft. On the 260 ft. haul five scrapers were worked, but with the longer haul another scraper was added. As the embankment was across a marsh of very soft material, two men were needed on the dump to help dump and handle the material. More men were put at work on the slopes so as to have them done when the cut was finished. The cost of this end of the cut was:

Foreman, 6 days at $3.00	$ 18.00
Scrapers, 38 days at $4.75	180.50
Plowing, 6 days at $9.20	55.20
Snatching, 6 days at $4.75	28.50
Loading, 12 days at $1.60	19.20
Dumping, 12 days at $1.50	18.00
Water boy, 6 days at $1.00	6.00
Sloping, 30 days at $1.50	45.00
Total	$370.40

The cost per cubic yard was as follows:

Foreman	$0.016
Scrapers	0.160
Plowing	0.048
Snatching	0.025
Loading	0.017
Dumping	0.016
Water boy	0.005
Sloping	0.040
Total	$0.327

Each scraper traveled 15 miles per day, and hauled 30 cu. yds. The average moved per team worked was 20 cu. yds.

For the entire cut of 2,453 cu. yds. the work cost:

Foreman, 13½ days at $3.00	$ 40.50
Scrapers, 76 days at $4.75	361.00
Plowing, 13½ days at $9.20	124.20
Snatching, 13½ days at $4.75	64.12
Loading, 27 days at $1.60	43.20
Dumping, 19½ days at $1.50	29.25
Water boy, 13½ days at $1.00	13.50
Sloping, 32 days at $1.50	48.00
Total	$723.77

The cost per cubic yard was:

Foreman	$0.017
Scrapers	0.149
Plowing	0.050
Snatching	0.026
Loading	0.017
Dumping	0.011
Water boy	0.005
Sloping	0.020
Total	$0.295

This makes an average per scraper day of 33½ cu. yds. and an average per team worked per day of 21 cu. yds. The average haul for the material was 325 ft.

In order to properly analyze these results and tell the relative costs it will be well to put the unit costs in one table as follows:

	1,320 cu. yds. 260 ft. haul	1,133 cu. yds. 400 ft. haul	2,453 cu. yds. 325 ft. haul
Foreman	$0.017	$0.016	$0.017
Scrapers	0.137	0.160	0.149
Plowing	0.052	0.048	0.050
Snatching	0.027	0.025	0.026
Loading	0.018	0.017	0.017
Dumping	0.008	0.016	0.011
Water boy	0.006	0.005	0.005
Sloping	0.002	0.040	0.020
Total	$0.267	$0.327	$0.295

This shows that the cost of the scraper work increased as the length of the haul increased, but as five scrapers were used on the 260 ft. haul and each scraper moved 34 cu. yds. the whole gang moved 170 cu. yds. per day. On the 400 ft. haul, six scrapers were used, and as each scraper moved 30 cu. yds. per day, the whole force moved 180 cu. yds. per day, which is the cause of the reduction of the foreman, plowing, snatching, loading and water boy items, in column 2. This clearly shows that in the five scrapers the loading force was not kept busy during the entire day, and calls attention to the fact that more scrapers were needed in the run. To have added another scraper would have meant that the gang would have moved about 200 cu. yds. per day, which would not have been too much material for one snatch team to load in that time, and this would have reduced the unit cost by at least 1 ct. A fact like this can only be brought out by trying an extra team on the run and keeping the detail costs. The increase of the cost of dumping in column 2 is due, as stated, to the fact that another man had to be used on account of the embankment being build over a marsh.

On the 400 ft. haul the scrapers traveled in a day 15 miles as against 12 on the shorter haul, this was partly due to the fact that on a short haul there is more lost team time for loading and unloading than on a longer haul. These teams were hired ones, and should have made a greater distance than this in a day, which shows the importance of a contractor always having some stock of his own on a job, to act as pace makers.

Another thing of interest is that with hauling material two ways from a cut with different lengths of hauls, as generally occurs, different conditions have to be met at each end, and a common cost is hard to estimate unless a close analysis is made.

With costs such as are shown above, kept on the work, and the day's work measured up at night, it is possible to tell each day how any job is being handled. With this being done changes can be made to see if the cost can be reduced, and the best method selected, so that wastes will be discovered and cut out while the job is going on, and not after it is finished.

With a level rod and a Locke level the yardage moved each day can be quickly measured up from the cross section stakes. These stakes should be so protected that teams cannot knock them out.

From the last table it will be noticed that the sloping of this cut, which was in a sandy loamy material, easy to plow and pick, cost 2 cts. per cu. yd. distributed over the entire yardage of the cut.

For other costs of wheel scraper work see Engineering-Contracting, Sept. 4, 1907, page 142, and Sept. 25, page 184.

The smelter production of copper in the world in 1906 was 1,596,973,700 lbs., while in 1905 the production was about 1,545,137,000 lbs. In 1906 the smelter output of the United States was 57.47 per cent of the world's total production, and in 1905 it was about 57.52 per cent.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Data on Oiling Park Roadways at Kansas City, Mo.[*]

During the past year the entire mileage of the park roadways of Kansas City, Mo., was treated with oil, the greater portion being given two treatments. The first application was made during May, June and July, 1907, a total of 375,415 sq. yds. of pavement being oiled. A total of 120,477 gallons of oil was used for the total cost of the application being $5,559.83, or an average cost of 1.48 cts. per square yard. In this application about .32 gallons of oil was used per square yard of pavement.

The second application was made during August, September and November and involved the oiling of 259,730 sq. yds. in addition to the 375,415 sq. yds. covered by the first application. The distribution and cost of this work was as follows:

	Sq. yds.	Gal. oil.	Cost oil.	Labor and material.	Total cost.	Cost sq. yds.
North and East Dist.	198,702	43,389	$ 789.40	$ 928.74	$1,718.14	$0.0086
South Dist.	125,022	25,585	450.58	377.79	828.37	0.0066
West Dist.	90,459	16,317	242.48	254.89	497.37	0.0055
Westport Dist.	220,962	71,597	1,252.60	815.13	2,067.73	0.0094
	635,145	156,888	$2,735.06	$2,376.55	$5,111.61	$0.0008†

†Average

Regarding the labor and material item in the above table, Mr. Dunn informs us that this was practically 79 per cent. labor and 21 per cent. material. The items making up the material account are feed and shoeing of horses used on the work, repairs to harness and wagons, and a small amount of screenings used for dressing. The expense for materials furnished in the first application was considerably greater than in the second application for the reason that more limestone screenings were used. The organization of the gang used in applying the oil was simply teams for ordinary city sprinkling wagons, usually from three to four teams depending on the length of haul from the distributing plant, and from eight to ten ordinary laborers about equally divided between sweeping the screenings to the gutters ahead of the oiling and spreading the oil with brooms and casting the sweepings back over the oil after it was spread.

In this application about .247 gallons of oil was used per square yard of pavement.

The total cost of the oiling operations for the year was $10,671.44, divided as follows: Two applications on 375,415 sq. yds., $8,581.92; one application on 259,730 sq. yds., $2,089.52.

Residuum oil, 20 to 21 gravity, from the Kansas Field, was used in the work, the average price paid for the oil on track being $0.0184 per gallon, or 77¼ cts. per barrel of 42 gallons. The average cost on the roadways, including all labor, supplies and incidentals for the year was 1.68 cts. per square yard. A limited amount of sprinkling with water was done during the year, but in no case was water necessary after a road had been once oiled. As a comparison of the economy of oil over sprinkling with water, it is stated that the latter for the fiscal year ending April 15, 1907, cost $14,011.32. The approximate paved area (including asphalt and creosoted blocks) was 584,680 sq. yds., giving an average cost of 2.4 cts. per square yard. The increased paved area for the year 1907 over 1906 is approximately 91,500 sq. yds., or 15.6 per cent. The oiling operations for the year 1907 show that an average of two applications of residuum oil per year avoids the necessity of any sprinkling with water. Applying the cost per square yard of sprinkling with water for the year 1906 (2.4 cts.) to the increased paved area of 1907 over 1906, sprinkling with water for 1907 would have cost $16,207, the net saving in sprinkling with oil in 1907 thus being $5,536.

The methods of unloading the oil, preparing roadway, spreading, were as follows:

Two steel receiving tanks, of 8,000 gallons capacity, were erected at a total cost of $714.99, connected with a 4-in. pipe-line from receiving tank to the side track, permitting of unloading tank cars by gravity, the receiving tanks being also established at such an elevation as to permit loading the sprinkling carts by gravity from the receiving tanks. Two portable boilers were purchased at $67.50 each, for the purpose of heating the oil in tanks and in sprinkling carts. When the macadam was absolutely dry and hard, the entire surface of the roadway was swept clean of dirt and screenings. The sweepings were left along the edge of the gutter for protection to the cement work, then the oil was applied from the sprinkling-carts. To the regular sprinkling-carts was attached a tin trough, perforated with ¼-in. holes, to obtain an even distribution of the oil. The entire surface of the roadway was then flooded with oil and thoroughly broomed in, after which the sweepings from the gutter, with sufficient limestone screenings to form a slight dressing, were cast over the oil and thoroughly rolled with a steam roller.

---

[*] From a report to the Board of Park Commissioners by W. H. Dunn, Superintendent of Parks.

Obstacles to Construction Work in the Arid Regions of the West.[*]

BY F. W. WHITESIDE.[†]

As the title of this article would imply, the scarcity of water is the cause of many of the obstacles which the engineer must overcome and of the hardships he must endure in certain of the arid portions of this country. This applies for the most part to railroad location and construction. Nor do all troubles cease with the completion of the road, although they are certainly lessened to a great degree.

The preliminary survey party, usually composed of about sixteen men, requires, besides the usual outfit of tents, instruments, cooking utensils, etc., a line wagon to haul the men about, a water wagon and stationary tank, and a freight wagon to keep the party supplied with provisions, carry mail, and haul wood. Water sometimes must be haul from 35 to 50 miles. This takes about all of one team's time. Wood is also scarce and must usually be gathered at a point a long distance from camp, and provisions must often be hauled from 75 to 100 miles from the nearest source of supply. These necessary teams require a considerable amount of feed which must also be conveyed over this long distance, as in an arid country all horse feed has to be obtained elsewhere.

After the railroad line is finally located and cross-sectioned, the contractor moves in and his difficulties are those of the engineers multiplied many times, as he has several hundred head of stock to feed and water, and twice as many men. On account of the unpleasantness of his surroundings, the ordinary laborer, usually designated "hobo," "beau" or "blanket-stiff," stays only long enough to accumulate a "stake" large enough to enable him to move on. As the amount of this stake varies from $5 to $25, his stay is short and one sees a continuous stream of old (?) men leaving and new men coming to the grading camps. So scarce are laborers sometimes, that contractor's agents have been known to ship help 2,000 miles to a given piece of work. During the course of the journey about 50 per cent of the shipment deserts, so that after the contractor has paid the railroad fare and the men's board enroute and takes inventory of the "bunch" which lands, he finds himself away down the page on the wrong side of the ledger.

Think of hauling water 35 miles for 200 head of stock. And this is only a part of it. There was one piece of railroad construction in New Mexico adjoining the writer's division where no water of any kind was to be obtained for a distance of many miles except at a tiny dry ranch owned by a Mexican, one Blas Durand. He had two wells, each 140 ft. deep, with an ample supply of water. He made a generous living raising cattle, sheep and goats driving his flocks overland to the market at Las Vegas, a distance of 100 miles. The advent of a railroad did not interest him, in fact, he preferred the uninterrupted solitude of the desert.

---

[*] Extracted from the Journal of Engineering, University of Colorado, Boulder, Colo.

[†] Chief Engineer, The Victor Fuel Co., Denver, Colo.

When the railroad company talked of getting water of him he was courteous and polite, but shrugged his shoulders and shook his head. As water had to be obtained at any price, a contract was signed and entered into by which Durand agreed to furnish water, the company doing all pumping and the contractors doing all hauling themselves, at the rate of 1 ct. a gallon, thus netting this descendant of Spanish kings an income of $1,500 a month for a period of about 8 months.

On the writer's division, a good part of the water was hauled from brackish lakes distant from camp some 8 or 10 miles. This water had a taste very similar to a wooly mutton chop.

After the grade is completed, along comes the track camp which moves ahead some 10 miles at a time as the track progresses. This camp often consists of as many as 40 box cars in which the laborers sleep, eat, and die at times. At this camp are housed the track layers, surfacers and sometimes the bridge crews, although ordinarily the bridge crews are out ahead erecting bridges while the grading is in progress. To maintain the track laying camp, it requires 4 or 5 locomotives and an almost endless number of cars.

On one line of railroad in New Mexico, with which the writer was connected, the company sunk wells with churn drills every 10 miles, hoping to get good steaming water. Without exception these wells proved failures. They were drilled to depths varying from 500 to 1,000 ft. Many of them yielded no water at all, and those which struck the precious fluid had to be abandoned, as the water contained so much "gyp" and other alkaline compounds that a lomocomtive using it would not last a week.

It was therefore necessary, on certain portions of the construction, to haul train loads of water 250 miles to supply the immense track camp and its locomotives. As water cars of a sufficient number could not be obtained, water from some of the "wet wells" was tried in the locomotives, with the result that the sight of a half dozen dead engines all coupled together and one live one towing them into the shops, was nothing uncommon.

These are only a few of the difficulties which are met in an arid country when building a railroad. Those who have never seen the land of sand, mesquite and sage brush are inclined to ask why any one in his right mind consents to live in such a place. In answer the writer can give no reason excepting the strange spell this land casts over one. During the day the thermometer sometimes creeps up to 120° in the shade and the heat becomes intense, but when the sun drops behind the hills to the west and the full moon rises majestically over the sands in the east, the whole world is transformed; one forgets the heat and discomforts of the day, and falls under the spell of the most beautiful night a mortal is ever permitted to enjoy. Go where you will, you will never forget these moonlight nights and you will often find yourself pining for the sands, the mesquite and the sage brush of this enchanted country.

A Continuous Blue Printing Machine.

The accompanying cut shows what is, in all probability, the largest and longest blue print that has ever been made in one piece. The print is 54 in. wide and 120 ft. long, containing 540 sq. ft. of paper. This blue print was made in one of the government offices in Washington, on an Everett-McAdam Continuous Electric Blue Print Machine. One man handled the machine in printing, but two men were necessary to care for the wet paper during the process of washing and drying. The print was washed in a 10 ft. tank and sprayed with a hose, then hung up in long loops over sticks.

View Showing Blue Print, 120 Ft. Long.

The largest blue print, like all large things, is of interest. The largest locomotive in the world, even if built on the model of smaller ones, creates widespread interest, but when a large thing can be made as easily as a small one, and at the same time fills a long felt need, it not only excites wonder but is welcomed by those interested.

Many drawings, as maps and profiles, are made on long narrow pieces of paper. In the engineering world to-day blue prints are made from drawings for working purposes. It has been the custom to make prints of long drawings in sections and paste these sections together; an unsatisfactory and tedious job, as any one knows who has done this work. Some sections fit well to others, while to fit other sections would try the patience of Job. The Everett-McAdam machine does away with this method, as it will make prints not only many yards in length, but, if necessary, a mile long.

It prints quickly, is easy to operate, and it is said to make a print of uniform tone throughout the entire length of the paper. Any kind of prints, blue, white with blue lines, brown or, in fact, any kind of print made with light can be successfully made on this machine, so its manufacturers state. As electric lights are used, it can be worked both night and day.

This machine is manufactured by the Revolute Machine Co., 523 W. 45th street, New York.

A recent Consular Report states that one of the constantly growing imports into the Chinese Province of Shantung through the port of Tsingtau is old horseshoes. Chinese iron dealers buy the horseshoes and sell them to knife and tool manufacturers all over the province. It is claimed by the Chinese that the temper of this class of iron makes it the best obtainable for knives and cutlery and also good for other tools. The reason ascribed for this is that the constant beating the shoes have received under the feet of horses has given them a peculiar temper absolutely unobtainable in any other way, and that tools made from them are superior to all others.

The U. S. Senate has passed a bill appropriating $3,000,000 for a site opposite the grounds of the White House, for a building for the Departments of State, Justice and Commerce and Labor.

A bill has been submitted to the National Congress of Bolivia wherein it is proposed to authorize the executive of the republic to negotiate a loan for $2,500,000 gold for the construction of sewers and sanitation of the departmental capitals of the nation.

Methods and Costs; Some Old, Some New.

Testing Blasting Caps.—A good way of testing the strength of a blasting cap is to place it on a [illegible] in. clean white pine board with no surrounding tamping and then fire it. A triple force cap will blow a hole half way through the board; a quadruple force cap will break splinters through the opposite side of the board, and a quintuple force cap or a double strength fuse will blow a clean hole through a board.

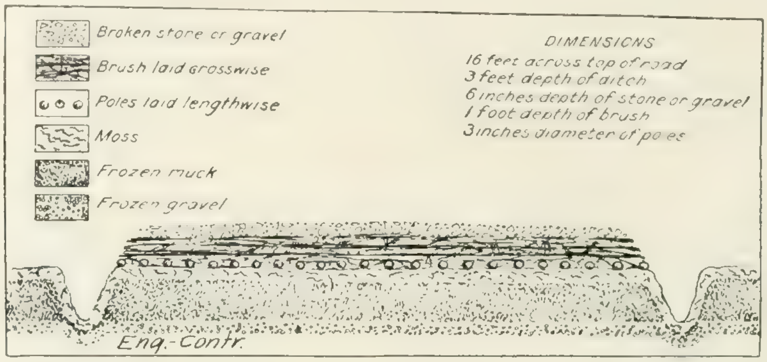
Excavation Table for Ditch Work.—The accompanying table was compiled by Mr. George M. Thomson, County Surveyor of Greene County, Iowa, to facilitate the making of estimates on county ditches. Mr. Thomson writes us that the table agrees very closely with bids received during the last two years for doing such work in Greene county. The prices given in the table are for excavating the trench, laying the tile and refilling the trench. The prices given are per foot deep and rod long. For instance, suppose the drain is to be 7.15 ft. deep and is to be laid with 12-in. tile. In the column under 7 ft. and opposite 12 in. will be found 40 cts, the price per foot deep; then 7.15x40=$2.86, the price per rod for 12-in. tile laid 7.15 ft. deep.

EXCAVATION TABLE FOR MAKING ESTIMATES ON DITCH WORK.

Average Depth in Feet.

Size of Tile.	5 ft.	6 ft.	7 ft.	8 ft	9 ft.	10 ft.	11 ft.	12 ft.	13 ft.	14 ft.	15 ft.
5 & 6-in........	$ .15	$ .18	$ .20	$ .25	$ .30	$ .35	$ .40	$ .45	$ .50	$ .55	$ .60
7-in	.18	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65
8-in	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70
10-in	.35	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75
12-in	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80
14-in	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85
15-in	.37	.42	.47	.52	.57	.63	.67	.72	.77	.82	.87
16-in	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90
18-in	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
20-in	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	1.00
22-in	.55	.60	.65	.70	.75	.80	.85	.90	.95	1.00	1.05
24-in	.61	.66	.71	.76	.80	.85	.90	.95	1.00	1.05	1.10
26-in	.67	.72	.78	.83	.88	.93	.98	1.03	1.08	1.13	1.18
28-in	.73	.78	.83	.88	.95	.98	1.03	1.08	1.13	1.18	1.23
30-in	.78	.83	.88	.93	.99	1.03	1.08	1.13	1.18	1.23	1.30
32 in	.85	.90	.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35
34-in	.90	.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40
36-in	.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45
38 in	1.00	1.05	1.10	1.15	1.20	1.15	1.30	1.35	1.40	1.45	1.50
40-in	1.10	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55

Preventing Gumbo Slides.—In the discussion of a paper on clay slides read before the Western Society of Engineers, Mr. A. S. Zinn stated that the Rock Island Road had been troubled a great deal in Texas and Arkansas by gumbo slides. The greatest trouble was in Arkansas on a line built about 10 years ago. The embankments were 10 to 15 ft. high and were constantly spreading out in the rainy season. Unsuccessful attempts were made to stop this spreading by driving piles close together at the foot of the embankment. A crosssection made at one place which had given considerable trouble and where cinders had been placed under the track, showed that the cinders were in a sort of trough caused by heavy traffic gradually pushing them into the embankment; at the foot of the embankment was continual sliding. One bad place, about 4,000 ft. long, was remedied by spreading this embankment out to a slope of 3 to 1, then building it up with good material and placing about a foot of ballast on top. On the Iron Mountain line on one division slides were cured by digging trenches, but instead of backfilling with riprap, old ties and coal at the bottom were put in covered with gumbo soil, and then burnt as they would burn gumbo for ballast. Before starting this fire trenches were dug straight out from the track to foot of embankment, the upper end of the trenches being connected by a deep ditch dug parallel to the ends of the ties. The ditches were dug 6 ft. deep or more, depending on the height of the embankment, straight out from the track, and about 2 to 3 ft. wide. After the material was burnt out, the ditches would be left filled with burnt clay, which would leave an opening for the water to get out. It was found that this gumbo when saturated with water, slides down to a slope of about 3 to 1, and then stops.



Sketch Showing Method of Road Construction in Yukon Territory.

Road Construction in Yukon Territory.—For the five-year period, 1899-1903, the sum of $1,030,118 was expended in constructing and maintaining roads and bridges in Yukon Territory, Canada. The average cost of constructing a wagon road was $1,500 to $3,300 per mile. The average cost of sled or winter trails, which, of course, are rarely used in summer, was $250 to $350 per mile, and the cost of repairing and maintaining those roads was $25 per mile per annum. The cost of repair and maintenance of wagon roads was $350 per mile per year. The accompanying cut shows the method of constructing a road, where frozen muck and gravel flats are traversed. This type of road, built over frozen ground costs $3,200 per mile, and can be maintained at much less expense than roads built along hillsides. In constructing roads of the type shown in the cut, it has been found best to leave the moss intact under the bed of poles, as it protects the ground from thawing. The black frozen muck, having the consistency of solid stone, remains as a firm bed. The ditches are cut either entirely in muck or partly in muck and partly in underlying gravel; these conditions vary with the thickness of the muck. The inside faces of the ditches are not always banked with sod, but such banking affords additional protection. In the construction of a road on a side hill, it is necessary to cut into the moss blanket, and as a result the frozen muck is thawed out by the sun and seepage water and becomes a soft, slimy mass. The cost of maintaining such roads has been found to be so much greater than for roads on flat grounds that the latter are now constructed, even if the distance between terminal points is greater.

The production of copper in the United States in 1906 was 917,805,682 lbs.

Some Types of Contractors' Cars.

The accompanying illustrations show some types of cars which the Arthur Koppel Co., Pittsburg, Pa., has recently designed to meet the requirements of contractors, railway companies, electric trolley lines, foundries, cement factories, brick yards, mines and quarries, and nearly all other industrial plants for the transportation of coal, scrap, dirt, stone, sand, slack, ashes, etc. The cars are of the Koppel Double Side "V" Dump Car Type and are built entirely of steel and iron in capacities of from 2 to 12 cu. yds. for standard or narrow gauge railroads.

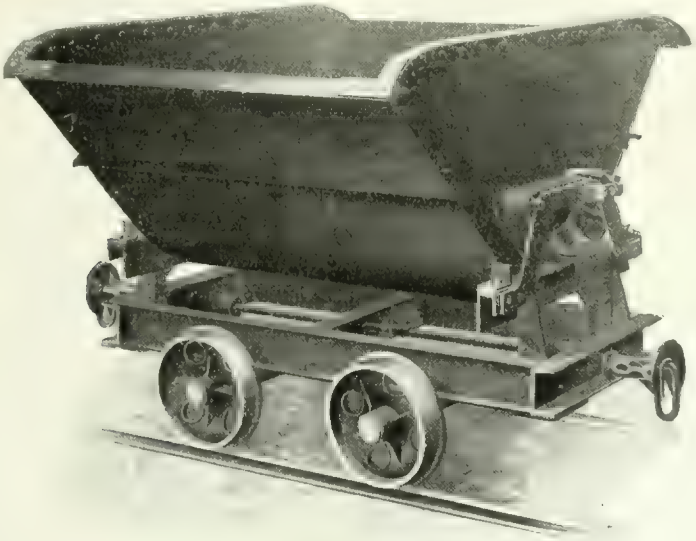


Fig. 1—Koppel Double Side Dump Car.

The body of the cars is one rigid unit, doing away with doors, straps, bolts and other loose parts, and the shape is such as to render it exceedingly strong The side and end plates of the body are riveted together so that any strain on the end plate is transmitted to the side plate, thus eliminating a concentrated strain, and consequently the wear and tear on one part. The cars are provided with a new locking device consisting of a simple latch which is located on the diagonally opposite corners of the body, so as to insure against accidental discharge. It can only be operated from the side opposite the dump and automatically locks the body when returned to the load carrying position. Should by accident one of the bodies become damaged it can easily be removed from the car and another substituted.

The discharge of the load is automatically performed by dumping the body by rolling it over and outward, the discharge taking place to the side of the rails and not between them. The cars can be discharged to either of both sides, and can easily be dumped by one man, without mechanical assistance. The car shown in Fig. 1 is built from 2 to 4 cu. yds. capacity, and is mounted upon a rectangular underframe built of heavy ship channel and can be provided with either Roller brass or babbit bearings. The cars are provided with continuous draw bars with special draft gear and link and pin couplers Cars of 4 and 6 cu. yd. capacity of the same general design but of heavier construction are also built. In Fig. 2 is shown a car of 12 cu. yds. capacity. It is composed of three separate "V" shaped bodies each holding 4 cu. yds., each operating individually, and having no connection with either of the others. The bodies are mounted on an underframe, and standard arch bar trucks suitable for cars of 60,000 lbs. capacity.

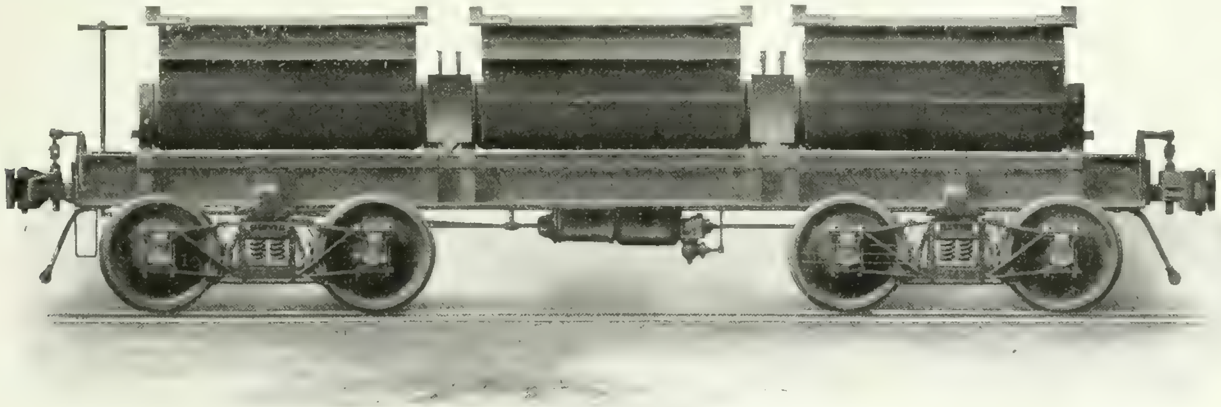


Fig. 2—12 Cu. Yd. Capacity Koppel Dump Car.

Annual Convention Illinois Society of Engineers and Surveyors.

The annual convention of this society held at Champaign, Ill., on Jan. 15, 16 and 17, 1908, was one of the most successful in its history. The report of the secretary showed the finances of the society to be in good condition with a surplus of some $700 in bank and no indebtedness. The membership has reached a total of 210. It was in the character and universal good quality of the papers read, however, that the convention stood out most prominently. There were seven sessions and so far as practicable, each was devoted to papers on allied subjects; thus, the first session was devoted to water-works and sewers, the second to streets and roads, the third to power plants, the fourth to drainage, the fifth to general business and an illustrated lecture, the sixth to surveying and reinforced concrete, and the seventh to railways. In future issues we shall give those portions of the various papers that are of most interest to our readers, but here we will merely make a running review of their general character.

The sessions were held in one of the lecture rooms of the engineering building of the University of Illinois at Urbana, Ill. Dean W. F. M. Goss, of the Engineering Department, welcomed the society in a brief address which was acknowledged for the society by Mr. J. W. Alvord. Mr. C. W. Burdick then delivered an excellent presidential address on the subject of the influence of various means for exchange of knowledge upon the development of engineering and upon the education of engineers.

The papers on water-works and sewers included a description of concrete sewer work at Decatur, Ill., by Mr. Alexander, and one on the cost of sewer construction by G. C. Habermeyer, both of which contained data of value to contractors and city engineers. The work of the new 73d street water-supply tunnel for the city of Chicago was briefly described by Mr. H. M. Ely, of the Chicago City Engineering staff. Other papers at this session were: "Operation of a Mechanical Filter Plant," by C. H. Cobb; "Municipal Water Supplies from Streams of Illinois," by Mr. J. Barrow, and "Municipal Improvements at Cairo, Ill.," by Mr. W. B. Thistlewood.

With the exception of a single paper by Prof. A. N. Talbot, describing and illustrating by lantern views the work being done at the University of Illinois in testing reinforced concrete, all the papers of the second session related to streets and roads. Prof. Talbot's monumental work in testing reinforced concrete is so well known and so justly famous both in this country and abroad, that his talk may be passed with this comment. Two of the papers on road work originated with the Illinois Highway Commission; one by Mr. A. N. Johnson, the commission's engineer, gave a concise outline of the educational purpose of the commission and the procedure it followed in its work and one by Mr. C. Older, describing the standard design reinforced concrete girder highway bridges worked out and being built by the commission. For spans up to 20 ft. the standard design is a reinforced concrete slab and for spans from 20 to 50 ft. it is a through girder bridge of reinforced concrete. Mr. Linn White, engineer South Park Commission, Chicago, Ill., presented a paper describing the work being done by the commission in making bitumen and tar treated macadam streets and park roads. A paper discussing the proper composition and construction of binder course for asphalt pavements was read by Mr. J. A. Gableman, of the engineering force of the city of Chicago, and Mr. J. B. Hittell, of the same force described the process of making creosoted blocks for paving and gave results of impregnation tests.

The papers read at the third session comprised one on "Developments in Gas Engineering," by Mr. C. M. Garland, one on "Modern Power Plant Practice," by Mr. J. C. Thorpe, and one on "Metallic Filament Lamps with Special Reference to Street Lighting," by Mr. J. M. Bryant. The session closed with a summary by Prof. L. P. Breckenridge, of the work being done by the University of Illinois in investigating the possibilities of smokeless combustion of Illinois coals. As the results of these investigations have been printed as a bulletin for free distribution they will not be considered further here.

As drainage and over-flow land reclamation constitute a very important part of the engineers' work in Illinois, the papers devoted to these subjects at the fourth session were unusually attractive. Papers were read by Prof. H. F. Bain, Mr. Isham Randolph, J. G. Melluish, P. C. Knight, Jacob A. Hurman, L. B. Boswell, G. A. Ralph and J. O. Wright. Specific mention of these papers in the space at our disposal is impossible. Altogether they presented a remarkably good idea of the drainage problems being solved by the engineers of Illinois and of the methods of work being followed in their solution.

At the fifth session all the time except that required for transacting routine business was devoted to a talk illustrated by lantern slides on "Engineering in Mexico," by Mr. J. W. Alvord. The papers of the concluding sessions were as follows: "Recent Improvements in Surveying Instruments," C. C. Wiley; "Concrete Monuments for Lot Corners," A. L. Webster; "Topographic Methods and Results in Illinois," W. H. Herron; "Topographic Mapping in the Bottom Lands," E. W. McCrary; "Notes on Architecture," N. C. Ricker; "Reinforced Concrete Building Construction," R. V. Engstrom; "Economic Efficiency of Rectangular Concrete Beams," F. O. Dufour; "Railway Switching Yard," G. W. Pickels; Drainage Areas and Waterways," M. L. Enger; "Construction of South & Western Ry.," J. E. Shephardson.

The society re-elected its old officers for another year.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0544. **Gas and Gasoline Engines.**—The New-way Motor Co., Lansing, Mich.

This 34-page pamphlet is devoted almost entirely to directions and suggestions to operators of 4-cycle gas and gasoline engines. Sectional illustrations of working parts of the engine are given and following them are complete directions for setting up, operating and taking care of each part. The directions are unusually complete and should be of interest and aid to every person using a gas or gasoline engine. It is unusual to find trade literature telling how to operate machines and how to treat them when out of order, and this pamphlet deserves commendation because it goes so fully into these unusual details.

No. 0545. **Scaglioline.**—Fireproof Partition Co., New York City.

Scaglioline as described in this pamphlet is a mixture of plaster of paris, chemicals and well burnt cinders. This mixture is molded into blocks which are used for fireproof partition construction. The pamphlet describes the characteristics of these blocks, gives dimensions and shows a number of illustrations of partitions. Some of the results of fire tests of such partitions are also briefly stated.

No. 0546. **Rock Drills.**—"Wood" Drill Works, Paterson, N. J.

This circular gives weights, dimensions, etc., of various sizes of rock drills made by the above named company. It also describes briefly a number of pieces of rock excavation in which "Wood" drills have been used.

No. 0547. **Electric Fans.**—The Emerson Electric Mfg. Co., St. Louis, Mo.

This is a very well written 60-page pamphlet devoted to alternating current fans. The various type of fans are illustrated, the construction of each is described and there is the usual catalog information. The descriptions in the text explain the design of the fans and the application to special purposes and have been well prepared.

No. 0548. **Pumping Machinery.**—Knowles Steam Pump Works, New York City.

This catalog contains 173 pages. It is the company's revised general catalog of pumping machinery and includes only those types of machines which have become standards of manufacture by the company. Besides the illustrations and usual catalog information the pamphlet describes the construction of the company's single direct acting pumps, gives directions for setting up and operating pumps, and also directions for setting steam slide valves. The catalog is excellently printed and contains a large amount of information of interest to those operating pumping machinery.

No. 0549. **Flour Mill Machinery.**—Allis-Chalmers Co., Milwaukee, Wis.

This is a very handsomely printed book of 65 pages describing the construction of a number of flour mills which have been equipped with machinery by the company named. The pamphlet describes in detail the Keewatin Flour Mill recently completed by the company at Keewatin, Ontario. A distinctive feature of this plant, which has a capacity of 5,000 barrels daily, is the electrically driven apparatus. Standard induction motors for alternating current are used not only in the mill but also for operating all the machinery in the elevator building. The description is very full and complete and should be exceedingly interesting to mill manufacturers.

No. 0550. **Aquabar.**—American Cement Waterproofing Co., Philadelphia, Pa.

The material described in this catalog is a solution which is to be added to cement to make it waterproof. The general character of the solution and the method of using it are described together with results of waterproofing and strength tests.

No. 0551. **Trench Machines.**—Geo. F. Lambert, Des Moines, Iowa.

This 16-page pamphlet illustrates and describes in a general way the construction and operation of the Parson Traction Trench Excavator. The text, which is very well written, describes the arrangement by which these machines are sold to contractors and also enters into the method of operating the machine in some detail. The pamphlet is an interesting one and should be secured by those thinking of using trench excavators.

No. 0552. **A Draughting Instrument.**—Ready Mfg. Co., Rochester, N. Y.

The instrument described in this folder is a metal affair which can be carried in the pocket and which is intended to perform every service that can be performed by T-square, compass, triangle and protractor. The circular illustrates this instrument and describes briefly the method of using it.

No. 0553. **Perforated Metals.**—Hendrick Mfg. Co., Carbondale, Pa.

The above named company manufactures a complete line of perforated metals for screens and other purposes where such metal is used. This 60-page pamphlet illustrates and describes briefly the several styles of metal and also shows revolving and other screens used in stone-crushing and other plants. The pamphlet contains a number of useful tables.

No. 0554. **White Portland Cement.**—Blanc Stainless Cement Co., Allentown, Pa.

This circular describes briefly the special Portland cement made by the above named company for use where an absolute white color and a stainless quality are desired. Results of tests of this cement are given.

No. 0555. **Centrifugal Pumps.**—De Laval Steam Turbine Co., New York City.

This is an unusually well printed and well written pamphlet of 48 pages devoted entirely to the special turbine pumps manufactured by the above named company. The pump is first described with illustrations of its various parts. This description is followed by a discussion of pump efficiency. Then each of the several styles and sizes of pumps is described and illustrated briefly. Results of tests of the pump are given and there is also a considerable amount of general information of value to pumping engineers and others.

No. 0556. **Stand Pipe and Water Towers.**—Tippett & Wood, Phillipsburg, N. J.

This pamphlet of 32 pages illustrates some of the stand pipes, water towers, smoke-stacks and storage tanks constructed by the above named company. An interesting feature of the pamphlet is the designs prepared by eminent architects for structures to cover stand pipes and tanks.

No. 0557. **Hoisting Engines.**—Lambert Hoisting Engine Co., Newark, N. J.

This 52-page pamphlet is devoted exclusively to a description of the use of hoisting engines in logging work. The several styles of engines used are described and illustrated and there are a large number of photographs showing actual logging plants in operation. The pamphlet is an interesting one and shows very clearly the possible applications of hoisting engines to this class of work.

No. 0558. **Paints, Compounds, Varnishes.**—A. Grothwell, 136 Liberty St., New York.

Preparations for waterproofing, acid proofing, roof paint, varnish, boiler and stack paint, pipe fitters compound, preservative paint and many other compounds are listed in this 60-page pamphlet. Over 200 uses for these preparations are shown.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class matter April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

A Brief Consideration of Reinforced Concrete Pole Line Construction...65

CONCRETE SECTION:

Recent Experiments in Concrete Pole Construction with Figures of Cost..66
Annual Convention Iowa Association of Cement Users..................68
Method of Raising Holland Dykes by Coping Walls of Concrete..........68

EARTH AND ROCK SECTION:

The Cost of Excavating a Sewer Trench With a Potter Trenching Machine 69
An Orange Peel Bucket Handling Rock 70
Cost of Trimming and Dressing Frozen Ground.........................70
Method and Cost of Drilling Test Holes in Earth by Hand, Taking a Core 71

GENERAL ARTICLES:

Suggestions for the Practical Application of Felt and Bitumen Waterproofing 72
Computation of the Values of Water Powers, and the Damages Caused by the Diversion of Water Used for Power 73

METHODS AND COSTS:

Breaking Up Pavement Surface—Apparatus for Extracting Asphalts with Solvents—Electrically Operated Dredging Plant—Data on Street Cleaning at Minneapolis—Scraper Work—Contract Labor Costs at Providence, R. I..........................75
CATALOGS WORTH HAVING..............76
PERSONALS 76

A Brief Consideration of Reinforced Concrete Pole Line Construction.

The structural efficiency of the reinforced concrete pole is open to small doubt. Stated another way, the possibility of molding a reinforced concrete pole which in combined strength and flexibility will meet all demands of trolley, telegraph, telephone and power transmission line works seems to be demonstrated by experiment. A record of some of these experiments is published in another column of this issue. As a structure the reinforced concrete pole is satisfactory at least in a very large measure. It is strong and reasonably flexible, its durability obviously exceeds that of wood or even steel, it costs molded under favorable conditions but little more than does a wooden pole framed and painted ready for erection. Why, then, is the reinforced concrete pole not certain to be immediately the successor of wooden poles for electric transmission line work? The answer lies in the difficulties that surround the handling of concrete poles.

Only one step has been taken in pole line construction when the poles have been molded and cured. Two other steps follow. One is to transport and distribute the poles along the route of the line; the other is to erect the poles in place after they have been distributed. The obstacles which concrete poles offer to transportation, distribution and erection as compared with wooden poles are great. The concrete pole is not merely heavier, weighing from a ton for 30-ft. poles to 1¾ tons for 40-ft. poles, but it is more brittle and less durable under rough handling. For example, we cannot confidently conceive of concrete poles being safely rolled off a flat car with a drop onto the right of way.

Two ways of handling the problem of transportation and distribution occur to mind. One way is to mold the pole at its site and the other is to mold it in a central molding yard and transport it to its site. To mold the pole at site involves the transportation to the site of concrete materials, including in many cases the water used, and of the molds, mixing boards, tools, etc. A molding train consisting of a locomotive and one or two cars would be required, and this or another train would have to cover the same ground a second time and some time later to strip and collect the molds and erect the poles. Altogether, we shall be correct in assuming a greater obstruction to regular traffic and considerably more plant and particularly more form work in molding poles where they are to be set than in molding them at central yards and distributing them ready molded. The natural difficulties of molding poles at site in ordinary line work seem clearly to eliminate this method from practical consideration.

Turning now to the plan of molding the poles in central yards located, say, at convenient gravel pits along the line, it will be seen that it involves special pole erecting trains. In brief, the poles would be loaded onto cars by yard derricks for hauling to the work. The erecting train itself would be provided with a derrick capable of lifting a pole and of reaching far enough to set it in the hole previously dug for its reception. This method appears, by all odds, to be the simpler and cheaper of the two and is the one which practice so far recommends.

The preceding remarks refer particularly to telegraph and trolley line work where train service is available at the least expense. For telephone or cross-country transmission line the problem assumes an entirely different phase. A number of telephone companies have, during the last year or two, taken the question of concrete poles under careful consideration, with the invariable conclusion that the difficulties and cost of transportation and erection precluded any general attempt to substitute concrete for wood poles at their present relative costs.

Under the favorable conditions mentioned by Mr. Webber in the article which we publish elsewhere concrete poles are figured to cost about $7.50 for a 33-ft. pole molded. To these costs must be added the cost of transporting and erecting and on these we have absolutely no reliable cost figures. In this connection the reader may study to advantage the cost of wooden trolley pole line construction published in our issue of Dec. 11, 1907.

The Association of Licensed Cement Manufacturers was organized in New York City on Jan. 9, 1908. The purpose of the association includes the general betterment of the mechanical and chemical processes used in making cement, the improvement of the quality of cement and the establishment of an association laboratory for cement tests and experiments. The association has developed out of the long series of disputes and lawsuits over the rotary kiln patents of Messrs. Hurry and Seaman and of Mr. Thomas A. Edison. In 1906 the North American Portland Cement Co. was organized with the purpose of taking over these disputed patents and the licensing thereunder of Portland cement manufacturers. Already companies have been licensed representing in the aggregate nearly 70 per cent of the total annual output of cement in the United States. It is these companies that constitute the association above mentioned. It is understood that all existing and properly equipped cement plants will be granted licenses and admitted to membership.

An agreement has been signed by China with an English-German syndicate for the loan of £5,000,000 for the construction of the Tientsin-Chinkiang R. R.

New York State Superintendent of Public Works F. C. Stevens in his annual report recommends that Congress be asked to join with the state in constructing a deep waterway from the Hudson river to Lake Ontario.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Recent Experiments in Concrete Pole Construction, with Figures of Cost.

The increasing cost of wooden poles for telephone, telegraph, trolley line and other electric transmission line work is leading engineers seriously to search for some substitute material. This material is believed by a number of engineers to be reinforced concrete and within the last year or two there have been quite extensive studies of reinforced concrete pole construction. The results of some of these studies are given in the succeeding sections, and in connection with them the reader will do well to consult the article published in our issue of November 20, 1907, describing the construction of 150 ft. transmission line poles for the Lincoln Light & Power Co. in Ontario and giving the methods adopted for computing the stresses.

Comparative Strength Tests of Concrete and Cedar Poles.—In 1906 two forms of reinforced concrete poles were tested in comparison with two 30-ft. selected cedar poles for Mr. G. A. Cellar, Superintendent of Telegraph, Pennsylvania Lines west of Pittsburg. The concrete poles were made and the tests conducted by Mr. Robert A. Cummings of Pittsburg, Pa. Both poles were 8 ins. in diameter at the top and 13 ins. in diameter at the base and both poles were molded hollow, with shells from 1¾ ins. to 3 ins. thick, for about two-thirds of their height and solid for the rest of the height. One pole was octagonal in section and one was square in section with chamfered corners. Each pole weighed approximately 3,500 lbs. Both poles were designed to carry 50 wires each coated with ice enough to make it 1 in. in diameter, and to resist a wind load of 30 lbs. per square foot. The poles were assumed to stand 100 ft. apart and were made 30 ft. high. These conditions are approximately equivalent to a concentrated load of 1,000 lbs. applied near the top of the pole. The reinforcement for both poles consisted of a peripheral ring of eight 24-ft. bars of round steel and alternately ¾ in. and ⅝ in. in diameter. Wooden blocks were molded into the poles for attaching clips and braces and through holes cored for cross-arm bolts. Both the wooden and the concrete poles were set approximately 5 ft. into 3x3x5 ft. concrete bases.

Mr. Cummings describes the method of conducting the tests as follows:*

"The load was applied through a band 10 ins. from the top of the pole by means of two ¾-in. wire ropes which passed over two 12-in. sheaves near the end of an inclined A-frame. These ropes received the hook supporting a differential chain hoist of 5 tons capacity. The base of the A-frame rested freely upon the front edge of the concrete foundation and inclined away from the poles at an angle of 45°. A pulley suspended from the extreme end of the A-frame carried the differential hoist, the lever arm and counterweight. The initial load applied at the top of the pole was thus reduced to 50 lbs. The total amount of applied load was measured by a simple lever. One end of which was supported on the platform of a 2,500-lb. capacity weighing scale, while the other end was attached to chain hoist. The two acted through a rocker fulcrum suitably supported. The load was applied or released by operating the differential hoist. In applying the load the hoist would reduce the distance between the hooks at any rate of speed desired. A graduated rule was fastened at the top of the pole being tested and extended back parallel with the line of poles crossing an arm containing a gage pin, from which point deflections were read. This arm was nailed to a rigidly braced upright erected near the rear telegraph pole. Deflections (Table I) were also read 12 ins. above the foundations by means of a movable rule. The platform for supporting the observer reading deflections at top of poles was suspended from a nearby bridge. The accompanying table gives the loads and corresponding deflections of four poles tested. The white cedar poles broke about 7 ft. above the foundation. The concrete poles failed by crushing of the concrete in the base of poles at the level of the foundation."

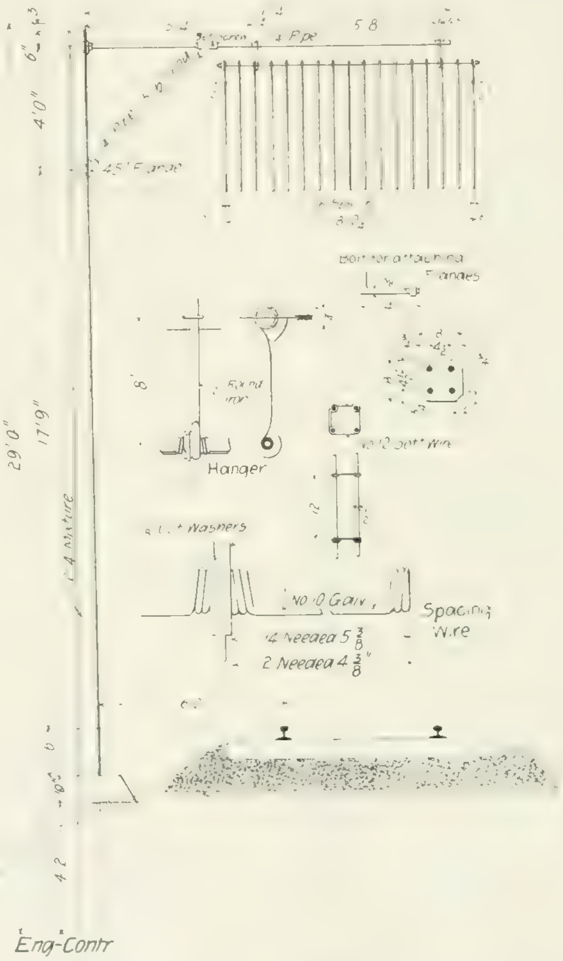


Fig. 1—Pole for Bridge Warning, N. C. & St. L. Ry.

Nashville, Chattanooga & St. Louis Ry.—Figure 1 shows the standard reinforced concrete pole designed to support bridge warnings by Mr. Hunter McDonald, Chief Engineer, Nashville, Chattanooga & St. Louis Ry. Originally the pole was molded with pole, cross-arm and brace all of concrete and in one piece, but this was found too expensive and the gas pipe cross-arm and brace were substituted. One pole of each construction has been in use over three years. The one with the concrete cross-arm shows considerable bending, but the other does not. The bill of materials for the concrete pole shown by Fig. 1 is as follows:

---

*Proceedings American Society for Testing Materials, 1907.

Shaft: ½ cu. yd., platform screenings, ¼ cu. yd. sand, and 2½ bags Portland cement.

Base: 1½ cu. yds. crushed stone, ¾ cu. yd. sand, and 6 bags Portland cement.

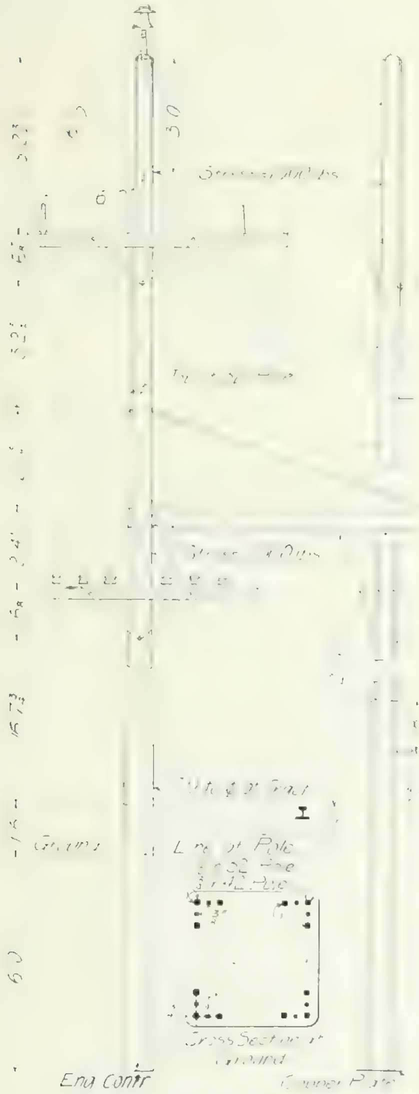


Fig. 2—Trolley Line Pole, 42 Ft. Long.

Bill of Material.

Item.	Lbs.
4 pcs. ¾ in x 42 ft. twisted steel bar.	321.2
8 pcs. ½ in. x 32 ft. twisted steel bar	217.6
8 pcs. ⅜ in x 16 ft. twisted steel bar.	61.2
20 pcs., total wgt. of steel.............	600.0
Concrete, 237 cu. ft., weight..........	3,030.0
Approximate weight of pole...........	3,630.0
Surface area of steel............	14,176 sq. in.
Base area of steel	5.375 sq. in.

No records of cost were kept.

Fort Wayne & Wabash Valley Traction Co.—This company operating some 150 miles of street and interurban trolley line proposes to make its renewals with concrete poles of the construction shown by Figs. 2 to 5. Fig. 2 shows the 42-ft. pole complete and Figs. 3, 4 and 5 show, respectively, the 32 and 30-ft. pole reinforcement. The weight and dimensions of the pole and the bill of material required are given for each size. Regarding the construction of these poles Mr. H. L. Weber, Chief Engineer of the road, writes:

TABLE I—LOADS AND CORRESPONDING DEFLECTIONS FOR FOUR POLES TESTED.

Test No.	Deflection at top, ins.	Load, lbs.	Deflection at bottom, ins.	Time.	Remarks.
		Octagonal Concrete Pole.			
1	3¾	1830	[illegible]	3:17	
	5¼	2230	[illegible]	3:18	
	½	50	[illegible]	......	Temp. deflec.—½ in.
2	8	2630	[illegible]	3:19	
	11¾	3030	[illegible]	3:20	Crks. No. 1 and 2.
	1¼	50	[illegible]	......	Temp. deflec.—2 in.
3	14¼	3430	¼	3:24	Cracks No. 3 and 4
	18	3210	[illegible]	3:25	Crk. 5 crshd. at bot.
	25½	3150	[illegible]	3:26	Pole brk at grnd lev.
		Square Concrete Poles.			
	¾	50		2:02	
1	2½	1830		2:04	
	3½	2230		2:08	
	¾	50			Temp deflec — 1 in
2	[illegible]	2630		2:10	
	8½	3030		2:11	
	3½	50			
3	31	3290			
	34½	3430	⅛	2:14	Crk. No. 1.
4	21¼	50			Temp. deflec.—22 ins Crks. 2,3,4, pl. crshd.
	39	3690		2:19	Crkd. at grnd. lev.
		Wooden Pole No. 1.			
	20	1830		11:50	
	22¼	2230		11:51	
	29	2630		11:52	
	35	2870		11:53	First crack.
1	36½	2950		11:54	
	38½	3030		11:55	
	50	3370		11:56	
	56	3430		11:57	
	66	3494		12:00	Pole brk. suddenly.
		Wooden Pole No. 2.			
	14	172			
1	37	2230			
	47	2530	......	11:03	Pole brk. suddenly.

"The cost of constructing concrete poles depends so much upon the location of the materials with respect to the points where the poles are to be erected that general figures are difficult to state. Having several good gravel banks at convenient points along our right of way, which is 120 miles in length, and having our road already built and the equipment available for handling materials and poles, we have been able to build concrete poles for about the same cost as a wooden pole all fitted up and painted. We figure that a 33-ft. pole costs $7.50 and a 45-ft. pole costs $15, at pit. It is difficult to figure the cost of molds, as one mold should be good for a number of poles, depending on the care that is taken of it.

Pittsburg, Ft. Wayne & Chicago Ry.—In 1906 this company erected 53 poles for a mile of telegraph line near Maples, Ind. The general construction of these poles is shown by Fig. 6. They ranged in height from 25 to 34 ft. The 25-ft. pole shown by Fig. 6 was 8 ins. square at the butt and 6 ins. square at the top, the corners being chamfered to a face 2 ins. wide so that above ground the pole was octagonal. The poles were set 4 ft. into the ground, and packed around with stone screenings. Some of the poles were erected within five days after molding.

Marshall Concrete Pole.—The following is a description of a test pole made by Mr. Wallace Marshall, Lafayette Engineering Co., Lafayette, Ind.

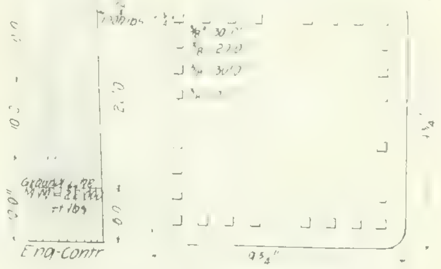


Fig. 3—Diagram of Reinforcement for 30-Ft. Trolley Line Pole.

Bill of Material.

Item.	Lbs.
12 pcs. ⅜ in. x 30 ft. twisted steel bar.	172.0
8 pcs. ⅜ in. x 20 ft. twisted steel bar.	76.6
8 pcs. ⅜ in x 10 ft. twisted steel bar.	38.3
28 pcs., total weight of steel...........	286.9
Concrete, 13.7 cu. ft.	1,758.0
Approximate weight of pole............	2,044.9
Surface area of steel..........	10,800.0 sq. in.
Base area of steel................	3.93 sq. in.

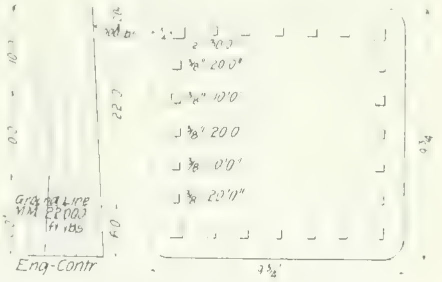


Fig. 4—Diagram of Reinforcement for 30-Ft. Trolley Line Pole.

Bill of Material.

Item.	Lbs.
4 pcs. ½ in. x 30 ft. twisted steel bar.	102.0
12 pcs. ⅜ in. x 20 ft. twisted steel bar.	114.7
8 pcs. ⅜ in. x 10 ft. twisted steel bar.	38.3
24 pcs., total weight of steel..........	255.0
Concrete, 13.7 cu. ft., weight..........	1,758.0
Approximate weight of pole..........	2,013.0
Surface area of steel..........	10,560 sq. in.
Base area of steel..............	3.812 sq. in.

"In November, 1905, I made a box form of three sides, having the top open, for a test pole. It was 35 ft. long. The lower 5 ft. was 10 ins. square; commencing at that point it tapered on all sides to 5 ins. at the top. From the 5 ft. point I put a triangular piece in each corner of the form of about 1½ ins. wide at the bottom and 1 in. at the top to chamfer the corners of the pole. At proper places of a standard line pole for line bracket, cross-arms and telephone box I bored holes through the forms, put machine bolts through it and let them extend about 2 ins. in the forms, screwing the nuts the full length of thread. In the top of the form, which was brought to a round point, I placed a 1½-in. pin in the center to leave a hole or an insulator pin. I then filled the form with concrete mixed by hand consisting of 1 part cement to 6 parts ordinary gravel, except a facing of about ½ in. of cement and sand 1 to 3. After covering the bottom of the form about 1½ in. I laid in the large end two ¾-in. Thatcher bars 25 ft. long, and in the top part two ½-in. Thatcher bars, lapping them about 4 ft. I left them in the form six days. At the expiration of 30 days we tested it as follows: We planted it firmly in the ground 5 ft. deep. At 25 ft. distance we planted a large cedar telephone pole. At the level of 21 ft. from the ground we fastened a wire cable from one pole to the other, which is about the height of a trolley wire. In the center of this cable we suspended a barrel. Into this barrel we loaded steel rivets gradually and watched results. The two poles began to bend as the load was applied. When the two were deflected about 21 ins. each toward the other I observed a small check come in the concrete pole about 10 ft. from the ground, and simultaneously checks appeared from the cable to the ground. We immediately stopped loading, took off the ballast, weighted it and calculated the horizontal strain and found it to be 975 lbs. The maximum moment would be at the ground, but the guess at size we made was about right, since the concrete cracked from ground to cable at almost the same time. When the load was removed the pole resumed its plumb position and remains so today, although being used for heavy guy wires. The bolts were unscrewed before moving them, leaving the nuts imbedded in the pole. After concrete set we screwed the bolts into the nuts and could not loosen them with an ordinary wrench. It took several heavy blows with a sledge hammer to break out the top socket. My conclusions were, however, that a wire ring or two of reinforcement should be placed about the pin for safety. Careful estimates were made as to cost of such a pole 35 ft. long if made in quantities in proper forms with material at the then market price, and gravel in pit at $7 actual cost. Comparing that cost with present price of pine poles and add to the latter the cost of trimming, chamfering, framing and painting, the concrete pole can be made for less money than the wood, provided no profit is paid a contractor. Figuring the moments on the pole tested I found the concrete failed at just about the time the limit of elasticity of the steel was reached, proving that it would be of no value without the steel. I believe that the concrete pole is practicable, and the only reason I have not put it to practical use has been the lack of time to do so."

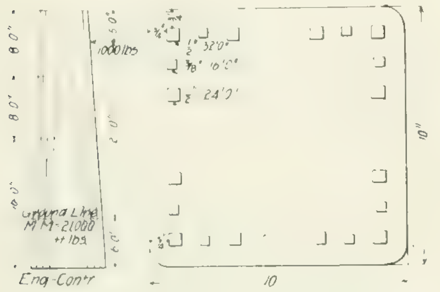


Fig. 5—Diagram of Reinforcement for 32-Ft. Pole.

Bill of Material.

Item.	Lbs.
4 pcs. ½ in. x 32 ft. twisted steel bar.	108.8
8 pcs. ½ in. x 24 ft. twisted steel bar.	163.2
8 pcs. ⅜ in. x 16 ft. twisted steel bar.	61.2
20 pcs., total weight of steel..........	333.2
Concrete, 15.1 cu. ft.	1,960.0
Approximate weight pole	2,293.2
Surface area steel	9,546 sq. in.
Base area steel	4.125 sq. in.

Annual Convention Iowa Association of Cement Users.

The annual convention of the association will be held at Des Moines, Ia., on Feb. 19, 20 and 21, 1908. The sessions will be held in the assembly hall of the Savery Hotel, which will be the headquarters. Small exhibits will be given space in the convention hall, and the corridors and parlors of the hotel. Heavy exhibits and exhibits of machinery in operation will be provided for near headquarters. The charge for exhibition space will be 10 cts. per sq. ft., with a minimum charge of $5 to one exhibitor. Papers are arranged for from Richard L. Humphrey, Dean A. Marston, Iowa State College; Thomas H. MacDonald, Iowa Highway Commission; H. K. Dodge, F. L. Reeder, and others. Applications for exhibition space and information will be attended to by Prof. Ira A. Williams, Secretary, at his office at the Iowa State College, Ames, Iowa.

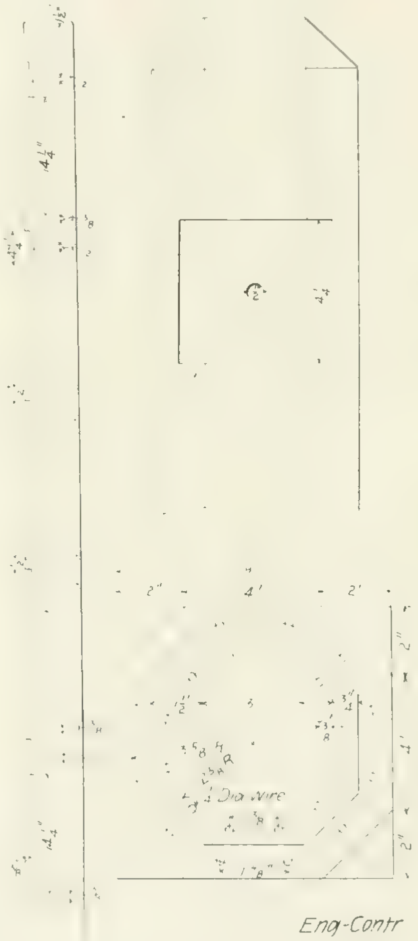


Fig. 6—Diagram Showing General Construction of Pole for Telegraph Line on P., Ft. W. & C. Ry.

Method of Raising Holland Dykes by Coping Walls of Concrete.*

The accompanying sketches show the method adopted for raising the elevation of the Zierikzee Dyke in Holland. A flood on March 12, 1906, had made it evident that this dyke was too low. Many longitudinal cracks had been observed and here and there the inner slope had been carried off by the overflowing water. The dyke had to be made 1.2 m. (3.94 ft.) higher. Its width at the top was and must remain 1 m. (3.28 ft.), so that it was impossible to raise the embankment unless it was widened at the same time, either on the inside or the outside. In the latter case an existing basalt slope paving would have had to be removed, which would have been expensive, while on the inside the course of a road would have had to be altered and the necessary land acquired. The concrete wall shown by Fig. 1 was, therefore, decided upon. As shown, the wall was reinforced. Expanded metal was used for reinforcement. It is remarked that the reinforcement should be placed as shown and that the placing should be done with particular care at the knee.

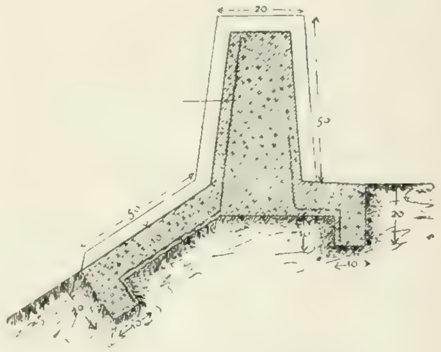


Fig. 1—Section of Wall.

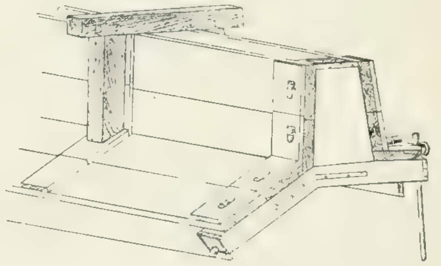


Fig. 2—Wooden Mold Used in Constructing Wall.

The method of constructing the wall is indicated by Figs. 2 and 3. At first isolated sections of the wall were built, using the form shown by Fig. 2. In erecting this form the end pieces were put in place and the footing slab at the back of the wall was concreted; the lagging for the back of the wall was then erected complete; then beginning at the bottom of the inclined slab the lagging was placed a piece at a time and the slab concrete was placed; finally the face form of the wall was erected and the concreting was completed. After the isolated sections of the wall had become hard the short spaces between them were built, using the form shown by Fig. 3. These connecting lengths were made of somewhat larger cross-section than the other parts of the wall, as shown by the outside full lines in Fig. 1. In this way the short sections appeared as buttresses at regular intervals along the wall. The concrete used throughout was composed of 1 part Portland cement, 3 parts sand, 4½ parts gravel and ½ part trass; sea water was used for mixing.

---

*Extracted from an article by H. Huisman, Civil Engineer, Zierikzee, Holland, in "Concrete and Constructional Engineering."

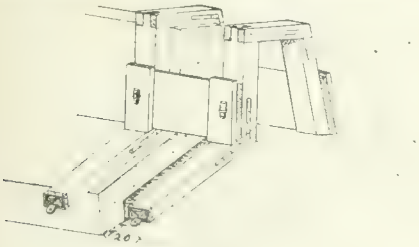


Fig. 3—Wooden Mold Used in Making Junction Pieces.

In reference to this method of construction Mr. Huisman states that for the dyke at Zierikzee, 20 per cent of the expenditure that would have been required to raise the dyke with earth, in the ordinary way, was saved by adopting reinforced concrete. In other places a much greater amount has been saved, especially where it was difficult to get the earth that was needed, or where there was a road on the top of the dyke for which room would have had to be found elsewhere if the dyke had to be raised by means of earth.

Reinforced concrete is to be used to reconstruct some 3,200 ft. of the board walk at Atlantic City, N. J. The portion of the walk which is to be reconstructed, extends from Connecticut to Pacific avenues, and is located between 300 and 500 ft. nearer the ocean than the site of the present walk. The change of position is necessitated by the building up of the land, which has taken place during the past four or five years. It is the intention of the city officials to replace the present wooden board walk as occasion demands, with a structure of a permanent nature. The contract as awarded calls for 800 ft. of a walk, 41 ft. wide and 2,400 ft. of walk, 21 ft. wide. The walk is supported on 380 concrete piles 16 ins. in diameter, varying from 28 ft. to 32 ft. in length. These piles are arranged in bents of four and two, 20 ft. from center to center of bent. The tops of the piles are connected by a reinforced concrete girder 24 ins. in depth and 8½ ins. wide. These girders form a support for the 14 x 4-in. joists. The upper surface of the walk is faced with 2-in. plank, thus retaining to a certain extent the appearance of the former boardwalk. The contractors for the new work are the Raymond Concrete Pile Co., Chicago, Ill.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of Excavating a Sewer Trench with a Potter Trench Machine.

The city of South Bend, Ind., has, during the past four years, built a sewer in the western portion of the city to furnish sanitary and storm water drainage. The area to be drained was about 800 acres. The sewer was 5½ and 6 ft. in diameter, and built of concrete.

During 1906, 2,444 lin. ft. of this sewer was built, the grade being 1 ft. in 1,500 for this section. Our article has to do with the cost of the excavation work for the sewer built during the season of 1906.

The section of the city through which this sewer was built was flat and marshy. The material, in consequence of this, was loose black soil for a depth of about 4 ft. Then sand and gravel were encountered, and for the last 4 or 5 ft. of the trench this material was water soaked. This made pumping necessary in the excavation work and also during the progress of the concrete construction.

The trench was 10½ ft. wide, and 18 ft. was the average depth. This gave 7 cu. yds. of excavation per lin. ft. of trench. Shoring of the sides of the trench was necessary. The first 2 or 3 ft. of the trench was excavated either by men casting the material from the trench or was plowed and moved with scrapers.

After this much excavation was done a Potter Trench machine, manufactured by the Potter Manufacturing Co., Indianapolis, Ind., was installed and used for all the work of excavation and for handling the concrete.

The trench machine was used to excavate from 5 to 6 cu. yds. per lin. ft., but, as no separate record was kept of the first excavation done, the entire cost of the excavation is figured as done with the machine.

The operation of this machine is very simple. The standard machine is 270 ft long, while the span is 10 ft. 6 ins. A light T rail is laid down on cross pieces on the ground. The metal frame is mounted on double flanged wheels that run on the rails. The carriage runs on 2 channels that are carried on the metal frame. This carriage is large and takes two buckets, while two men ride upon it to operate the buckets. The frame work that holds the channels can be well braced, as the buckets do not hang from the carriage but are carried above the channels. This also allows sheet piles or shoring to stick up above the street without interfering with the working of the machine, which is not possible with all makes of trench machines.

By using long cross pieces a wider width of ditch than the width of the machine can be built, the shoring sticking up outside of the rail if necessary, and yet the machine can serve the trench well. The engine for operating the carriage is at the end of the track. The machine does not have to be taken down, but is moved along as a unit as the sewer work is finished in sections. The buckets are lowered into the trench to be filled, and two loaded ones are picked up. These are carried back and dumped on a completed section of the sewer. If any part of the material has to be hauled away, a wagon drives under one end of the frame work, which is about 8 ft. above the street level, and the buckets are dumped into the wagon. With a machine of this character the backfilling is very inexpensive, as it is almost a part of the excavation, the men on the carriage doing all the work, except any ramming or puddling that may be required.

The machine hoists two buckets at a time, but if it is desired to use only one bucket, the other can be left off. Buckets varying in capacity from 1-3 to 1 cu. yd. accompany the machine. The buckets are of two styles, turn over and bottom dump buckets, both of which are round. Four men operate the machine, there being an engineer and fireman and 2 men on the carriage, the latter being laborers. The buckets are filled by laborers with picks and shovels in the trench. It is stated that the car or carriage can make a round trip in one minute, this includes lowering and hoisting two buckets. Naturally this rapid work is not often necessary, but the fact that it will do this shows how well constructed and easy of operation the machine is.

On the work described it was the custom to keep about 200 ft. of the trench open at one time. The material was taken from in front of the sewer and dumped on the completed portion. The excavation on top was dry, but as it neared the bottom, as previously stated, water was encountered. The following system of drainage was used. The water came from the gravel and sand. A sub-drain pipe was laid of second class and cull pipe, the bottom of this being laid 30 ins. below the grade of the invert of the sewer. The joints were loosely caulked with tufts of sod in order to prevent the fine sand from entering the pipe. Clean gravel of medium size covered the pipe. This permitted water to enter the pipe, through which it flowed to a sump at the lower end of the new work. This sump was 18 ins. below the grade of the drain pipe, and the water was pumped from the sump by a 6-in. rotary pump over a dam into the old portion of the work.

This drained the bottom of the trench so that the concrete was readily laid, and by keeping the pump going continually, allowed the concrete to set without being injured by the water rising in the trench. This pumping and drainage work is included in the cost of excavation, but a part of it could properly have been charged against the concrete work.

The wages paid for a 10-hr. day were as follows:

Engineer on trench machine	$3.00
Fireman on trench machine	1.65
Engineer for pumping	2.00
Fireman	2.50
Carpenter	2.50
Laborers	1.85

The cost of the various work per lin. ft. of trench was as follows:

Pipe for sub-drain	$0.33
Labor laying this pipe	0.35
Pumping water	0.45
Excavation and back filling	2.80
Setting and pulling shoring	1.04
Allowance for tools and gen. ex.	.25
Total per lin. ft.	$5.22

With 7 cu. yds. per lin. ft. of trench this makes a cost per cu. yd. of excavation for each of the above items as follows:

Pipe for sub-drain	$0.047
Labor laying this pipe	0.050
Pumping water	0.065
Excavation and back filling	0.400
Shoring	0.150
Tools and general expenses	0.035
Total per cu. yd	$0.747

The drainage, it will be noticed, cost a little more than 20 per cent of the total. The cost of excavation and back filling, and of shoring and filling the street piles for a trench as deep as this is quite reasonable.

In our issue of October 9, 1907, a photograph of the Potter Trench Machine is given, and some costs of excavating a sewer trench in Chicago.

The contractors for the work were Hoban & Roach. We are indebted to Mr. W. A. Morris, Asst. City Engineer of South Bend, for the information regarding this work. The construction of this sewer was described by Mr. Morris in a paper read before the Indiana Engineering Society.

The report of the engineers that have been studying the "Longitudinal" railway scheme from Arica to Santiago in Chili for the past year shows that of the 2,423 kilometers of line 669 kilometers are in operation, 197 are under construction and 1,557 are yet to be put under contract.

An Orange Peel Bucket Handling Rock

Rock that has been blasted and loaded on to cars is easily unloaded by dumping or pushing off the pieces by an unloader, but the task becomes a difficult one when the rock is loaded on scows, and in unloading it must be elevated to a higher level.

On the new passenger terminal of the Pennsylvania railroad in New York the excavation is entirely solid rock. This is blasted out and loaded by steam shovels into cars that dump the material into scows. These scows are towed to Greenville, N. J., where the rock is being used to make embankments for the Pennsylvania freight terminals. At Greenville the rock must be loaded again into cars and thus transported to place of final deposit. The rock varies in size from dust to boulders weighing 3 or 4 tons.

The problem of how to handle this material from the scows to the cars was solved by the contracting firm of Henry Steers, Jr., Inc., who are using orange peel buckets, manufactured by the Hayward Co. Buckets of 2½ cu. yds. capacity are being used, and it is stated that no difficulty has been experienced in handling either the fine rock or the large boulders, or even in handling the two sizes mixed together. The bucket loads and dumps itself automatically and the contractors state they have saved themselves thousands of dollars on this job by using the orange peel bucket. The accompanying illustration is made from a close range photograph of the bucket picking up stone from the scow.

The Hayward Orange Peel Bucket.

This work is illustrated in an especially fine edition of the Hayward catalog that has just been published. The catalog contains many fine half tones showing all classes of tools and machines manufactured by this company. It is 10x12 ins. and contains 152 pages. Numerous pen drawings showing various machines at work add to the attractiveness of the volume. The book is very artistically printed. It is essentially a catalog of digging machinery, and shows methods of handling all classes of earth and rock. Contractors and engineers wishing copies should apply to the Hayward Co., 97 Cedar street, New York.

Cost of Trimming and Dressing Frozen Ground.

In our issue of Dec. 18, 1907, page 346, we made some comments on surfacing or trimming and dressing earthwork. This is an item that means adding some cost to earthwork, except in a few cases, one notable example being large reservoir embankments. On such embankments, on the water side of the dike some class of paving work or rip rap is laid, to prevent the water from injuring the embankment, hence trimming is not needed, while on the down stream side, the bank is generally dressed off with soil or sodded, which allows of the cost of the trimming and dressing to be included in the turfing and sodding price.

On railroad construction both the embankments and cuts must be trimmed and dressed, and in this work is generally included the ditches in the cuts. The price paid for this work on railroads is included in the price of excavation, the contractor being paid for the yardage in the ditches. As a rule a contractor will try to do this class of work under favorable weather conditions, but occasionally he finds it necessary to do some part of it in a season that makes it much more expensive. In the example we are about to give this was the case. About 1,500 ft. of roadbed had to be dressed up to allow track to be laid at once. At the time the work was done the ground was frozen to a depth of about one foot. Naturally this added much to the cost.

The wages paid were: Foreman, $3.50; laborers, $1.50, and cart and driver, $3.50 for a 10 hr. day. From 14 to 18 men worked in the gang and while the ditches were being dug two carts were used, but after the bulk of the earth was moved only one cart was kept on the work. The cost was:

Foreman, 9½ days	$ 31.67
Laborers, 145½ days	218.25
Carts, 15 days	52.50
Total	$302.42

There was 3,200 sq. yds. of surface to be trimmed. About 2,300 sq. yds. were in the cut and the rest was on the embankment. Only a few places on the fill had to be cut down; the low places being raised with the material from the cuts. The cut was within a few inches of grade throughout, only about 100 cu. yds. being taken out of it, making an average of about 1 in. to be trimmed off the surface. From the ditches 133 cu. yds. were excavated.

The cost per square yard of surface dressed was as follows:

Foreman	$0.010
Laborers	0.068
Cart	0.016
Total	$0.094

Thus the cost was between nine and ten cents, when it is frequently done in the neighborhood of 1 ct. per. square yard on railroads. For other comparisons for trimming and dressing see Gillette's "Earthwork and Its Cost," page 34.

From this it will be seen that each man trimmed and dressed 22 sq. yds. per day Under favorable circumstances he would do about six times as much. Outside of the work in the ditches, only a small piece of the earth could be clipped off the frozen ground at a time. In the ditches picks could be used to advantage, but on the road bed it was necessary to cut off the few inches of earth with mattocks. Even then it took 10 or 12 pickers to keep three or four shovels busy loading the material into carts. The total cost per cubic yard of material so moved was $1.30. One man loosened and shoveled in a day about 1½ cu. yds.

These figures show conclusively how expensive this class of work becomes when the ground is frozen. The original cut was a shallow one, the total yardage in it being about 2,000. Thus the cost of trimming and dressing distributed over the yardage of the cut, makes a cost per cubic yard of 15 cts. It is needless to say the contractor did no more of this work than he was compelled to do.

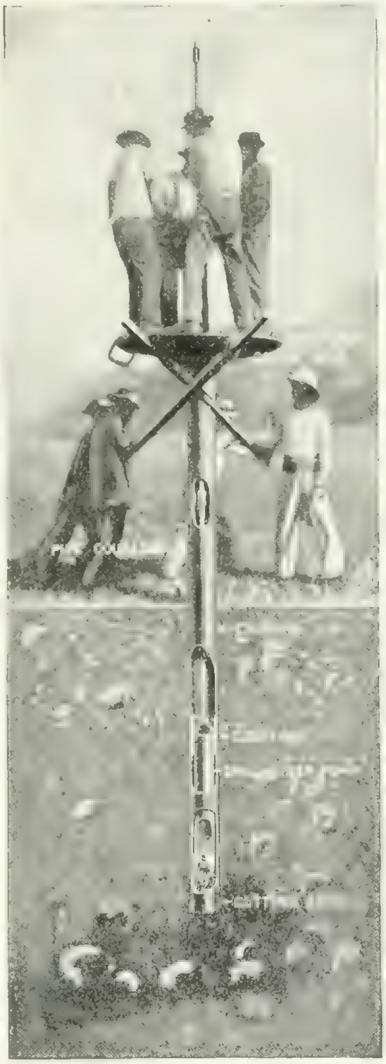
In the following table are given the highest daily records of steam shovels in the Department of Excavation and Dredging on the Panama Canal from December 1 to 24, inclusive:

Shovel No.	Date.	Location.	Cubic Yds	Kind of Material.
221	Dec. 3	Bas Obispo..	1,900	Rock and Earth
116	Dec. 3	Bas Obispo..	1,788	Rock and Earth
205	Dec. 21	Empire....	2,140	Rock and Earth
126	Dec. 4	Empire....	1,164	Rock ond Earth
222	Dec. 18	Culebra....	2 072	Rock and Earth
128	Dec. 2	Culebra....	1,960	Earth
211	Dec. 13	Pedro Miguel	3,164	Soft Rock
110	Dec. 6	Pedro Miguel	1,900	Earth
103	Dec. 13	Mindi.......	1,334	Rock and Earth
115	Dec. 21	San Pueblo..	1,450	Rock and Earth
54	Dec. 20	Caimeto Mul.	1,030	Earth

Shovels in the one-hundred class are 70-ton shovels with buckets of a capacity of 2½ cu. yds. Shovels in the two-hundred class are 95-ton shovels with dippers of a capacity of 5 cu. yds. Shovels in the fifty class are 45-ton shovels with dipper capacity of 1¾ cu. yds. The shovels are under steam for eight hours per day.

Method and Cost of Drilling Test Holes in Earth by Hand, Taking a Core.

In making test borings most boring machines use water to wash up the material or to make the drilling easier, hence these borings are called "wash borings." The water changes some earths materially, softening some and washing away fine sands. For this reason wash borings are not always satisfactory, where samples of the earth are desired. A machine that will do this work without water, and, at the same time, takes a core, is of great value to engineers and contractors.



Machine for Drilling Test Holes.

The accompanying illustration shows a light, inexpensive and portable machine that will do this work quite cheaply. Its operation is simple, and the general principle is as follows:

The drilling is done with one of several tools—adapted to the particular kind of material being drilled—attached to the drilling rod. The tool and rod are operated inside the casing by the men on the platform, who raise and drop them like a "churn" drill. The men on the ground rotate the casing, which has a sharp cutting shoe on the lower end. The casing, with its burden of platform and men, thus keeps cutting and sinking into the ground several inches ahead of the tool. A horse may be substituted for the men who rotate the casing.

The material which enters the casing is drilled and forced into a sand pump at the same time. The pump is occasionally lifted out of the casing, emptied and the contents noted. Any material can be penetrated until the solid bed rock is reached. An accurate core is obtained, and the exact nature of the ground drilled is readily shown.

Four-inch pipe is generally used, with a special coupling that makes a perfectly flush joint; that is, all of the couplings have the same outside diameter as the pipe, which makes it very easy either to sink or remove this casing. Instead of the 4-in. pipe or casing, 3-in. or even 2½-in. casing can be used if desired, and it will make more rapid work, but of course would give a smaller core.

After the hole is finished, the pipe is easily withdrawn because the casing, having been constantly rotated, is always loose, both while sinking and removing.

In estimating the cost of operating this drill there is little else to be calculated besides the labor, as the repairs constitute a small part of the operating expense. Of the laborers employed, one must be a foreman or driller, another an ordinary pipeman, and the balance of the crew common laborers. When the casing or piping with its platform is rotated by a horse, instead of the men on the ground, it effects quite a saving in the cost by dispensing with three or four men. If the ground does not contain heavy boulders, and the holes are not over 35 or 40 ft. deep, six men will be sufficient, or three or four men and a horse; the cost of this crew will generally be not more than $15.00 per day.

With the 4-in. size hole 50 ft. of hole per day have been drilled at a cost of 30 cts. per foot. Twenty-five to thirty feet of hole per day will be averaged through hard cemented gravel containing boulders.

Mr. Thos. G. Ryan used one of these drills on Long Island putting down a number of holes through sand and gravel, with occasional strata of clay, and in some cases encountering large boulders. About 40 test borings were made, each hole averaging 59½ ft., the total lin. ft. drilled being 2,454. The time consumed in this work was 73 days, working 9 hrs. per day. The cost given below includes the drilling, drawing the casing, and moving and setting up drill, thus covering a number of removals over a considerable period of time.

The total cost of the work was:

1 foreman 73 days at $4.00	$292.00
1 pipeman 73 days at $3.00	219.00
3 laborers 73 days at $1.50 each	328.50
1 horse 73 days at $1.00	73.00
Deprec., interest, renewals and incidentals	81.76
Total cost	$994.26

The average work done each day was 330 ft., which gives a cost per lin. ft. as follows:

Foreman	$0.110
Pipeman	0.080
Laborer	0.131
Horse	0.030
Deprec., int., renewals & incidentals	0.033
Total	$0.405

This is a very reasonable cost for this work, as a comparison with both wash and diamond drill borings will readily show. For records of cost of such borings see Engineering-Contracting, Jan. 9, 1907, page 17; March 13, 1907, page 100, and March 27, 1907, page 132.

This boring machine has had extensive use in various sections of the country for prospecting for minerals as well as for making tests for foundation work. It can also be used for making holes for blasting in earth where it would not be possible to carry a well drilling machine in rough country. When knocked down all the parts can readily be transported by men or on the backs of horses, so that it can be used where it would be almost impossible to carry a machine using steam power.

This machine is known as the Empire Hand Drill and is manufactured by the New York Engineering Company, 2 Rector St., New York. The company issues a catalog describing this machine, and also the method of operating it, that will prove of interest to engineers and contractors.

The following extract from a circular issued by Allis-Chalmers Co. to users of Gates Breakers is of interest to all users of rock breaking machinery: "Good oil is a necessity for the efficient operation of all classes of machinery, but especially is this true when the service is as severe as that required by a rock breaker. This machine is not only expected to operate continuously on as severe a duty as is required of any piece of machinery, but most frequently receives a proportionately small amount of attention and care. The necessity of repairing a breaker can, of course, not be entirely eliminated, but the amount of repairs required can be materially reduced, and the efficiency of the machine greatly increased by the use of the proper quality of oil. More than half the repairs required for a breaker are directly attributable to the use of poorly selected oil. An oil may be expensive and of excellent quality for some purposes, but too light or too heavy for use on a breaker, which would cause the same disastrous results as if a very poor oil were used. The fact that a breaker will operate for a day, a week or even months with a poor quality of oil, should not be allowed to deceive, for sooner or later there will be trouble, costing much more than had the operator procured the proper quality of oil at first."

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Suggestions for the Practical Application of Felt and Bitumen Waterproofing.*

(1.) No waterproofing, especially for difficult and water-pressure work, should be undertaken when the temperature is below 25° F. Fifty per cent better work can be done when the weather is warm. In cold weather the felt sheets are difficult to handle, the hot bitumen-cement chills and congeals too quickly, especially when it comes in contact with a cold wall, and it is difficult to obtain the perfect cohesion of the different felt layers.

(2.) Allow sufficient time, room and accommodations in which to properly apply the materials. The reverse of this rule, however, is the common practice. No other part of construction work depends more upon the perfection of details than waterproofing. Yet there is no part of such work which receives so little appreciation and consideration. To not make every provision for facilitating waterproofing work is a great mistake. No matter how conscientious a workman may be, he cannot, for example, do good work on a wall from the outside if the excavation is not wide enough from the wall to give him room in which to work, or on the inside of the wall if he has scarcely light or arm room, and is crowded upon by workers in brick, in cement, in stone, in steel, etc.; nor on the roof of a subway, under railway tracks, if there is not sufficient head and working room between the roof of the subway and the base of the tracks, etc. This lack of consideration in not providing time, room and the necessary facilities, and in allowing contractors to apply the materials in any haphazard way, so long as the materials are applied, is the real cause of so many past failures. Nothing pays better than good waterproofing, and nothing is more disastrous than poor waterproofing. Once water gets behind waterproofing, no waterproofing would have been preferable.

(3.) Design the structure properly to receive waterproofing. The design will either make impossible proper waterproofing, or will invalidate the best materials after they are in place. The line of waterproofing should be adapted to the nature and purpose of the structure, and be logical with the point of water-pressure.

(4.) Specify always that the waterproofing shall be done only by experienced and skilled labor. Roofing, for instance, is not waterproofing.

(5.) Thoroughly protect the waterproofing during and after application. The average laborer is no respecter of waterproofing, especially an elastic waterproofing, and will walk on it, roll wheelbarrows over it, throw tools, lumber, brick, stones, cement and debris thereon, to its serious damage. After arches are waterproofed it is a common mistake in placing the fill to not begin the fill at the base of the arch, but to dump it on the crown. The fill thus often breaks through and tears or strips the waterproofing from the arch surface. It is false economy to not always permanently protect waterproofing with a layer of brick or cement mortar.

(6.) Inspect waterproofing at all times during application. See that the materials as specified are used, and also that they are themselves up to standard; that the work is done carefully and skillfully, particularly in the out-of-the-way small difficult places; that the laps are not made 22 ins. when they should be 24 ins.; that the hot cementing material is applied, not one-fourth or one-half, but the entire width of the lap; and that it is applied *hot*, quickly and thoroughly; that full, clean and well-protected connections are provided; that the waterproofing is well protected at the end of the day's work; that no work is done except in the presence, and by the approval of, the special inspector appointed over the work.

If the inspector is himself not thoroughly skilled in waterproofing he is of no value. He might be an expert in steel or cement or caisson work, but without the right experience in, and the knowledge of, waterproofing, the waterproofing men under him could easily deceive him in important details of the very thing which is to make permanently safe and valuable the steel and cement. If the waterproofing is very important, expert direction and supervision should be obtained.

(7.) Do not depend on guarantees. The speaker has always contended that a waterproofing guarantee is practically worthless. A roofing guarantee is of value because the conditions are entirely different. In roofing the cause of and responsibility for leaks can be easily settled. Seldom, however, is there any recovery had under a waterproofing guarantee. Bonding companies are averse to supporting waterproofing guarantees because of the high risk. It will be found on close analysis that bonded guarantees do not, in fact, guarantee. Such, for example, is a bonded guarantee reading that the structure or surface to which the waterproofing is applied must remain "sound and stable." The very purpose of waterproofing is to waterproof the structure or surface in the event of its *not* remaining "sound and stable." Such a guarantee, of course, means nothing, except that the bonding or other company assumes no risk, but shifts it to the owner of the structure, who himself then guarantees that his structure or wall will not crack or injure the waterproofing. The waterproofing should accommodate itself to the wall, instead of the wall accommodating itself to the waterproofing. The best guarantee is work, intelligently, skillfully and honestly executed by a concern of reliability and reputation.

---

*Extracts from a paper read before the Boston Society of Civil Engineers by Edward W. De Knight and published in the "Journal of the Association of Engineering Societies" for December, 1907.

A strong case in point is a recent decision on a waterproofing guarantee by the United States Circuit Court of Appeals, Third Circuit, 144 Federal Report, 942. In a contract for the foundation of a building the specifications, after describing the waterproofing materials to be used, stated: "The whole to be made perfectly water-tight and guaranteed." On the completion of the foundation it leaked and payment was withheld from the contractor. The contractor contended that he had strictly followed the specifications and was not accountable for the result of the plans. The court upheld the claim of the contractor.

(8.) Do not use a set or standard specification. Each design must suit the exact conditions, and each specification must exactly suit the design. Using a set or standard specification frequently offsets the very purpose desired. It results in the customary but very serious mistake of placing the waterproofing details on the contractor. A contractor will apply anything that is specified, and, as a rule, is interested only in getting it applied as quickly as possible. Speed in waterproofing is undesirable and dangerous. The specification as to waterproofing, particularly in important work, should be clear and to the point in every detail. It should make the contractor responsible only for the proper application of the materials under the close observation and approval of the engineer.

The U. S. Forest Service has just established a laboratory at Washington, D. C., for investigating the structure of commercially important woods. The structure of the woods, sections lengthwise and crosswise, will be studied so as to separate by structure alone the various species of a genus. Analytical keys to the trees of each group will be worked out. These will be based on the arrangement and character of the pores discernible to the naked eye, or by a hand lens. The results will be published from time to time with good illustrations and placed at the disposal of lumber users. After all the important groups of wood, such as oaks, pines and firs, have been studied and the results published separately, the several monographs will be collected and published in one volume.

Computation of the Values of Water Powers, and the Damages Caused by the Diversion of Water Used for Power.

We abstract the following from a series of papers on this subject, that appeared in No. 3, Vol. 21, of the Journal of the New England Water Works Association. The first paper was by Mr. Charles T. Main. He says:

The following definition of market value was given to the witnesses who were to testify on values in a recent important lawsuit:

"'Market value' means the fair value of the property, as between one who wants to purchase and one who wants to sell any article; not what could be obtained for it under peculiar circumstances, when a greater than its fair price could be obtained; not its speculative value; not a value obtained from the necessities of another. Nor, on the other hand, is it to be limited to that price which the property would bring when forced off at auction, under the hammer. It is what it would bring at a fair public sale, when one party wanted to sell and the other to buy."

The definition of the damage due to the diversion of water was stated as, "The difference in market value, before and after the diversion."

The value of an undeveloped water power depends:

First. Upon its location, the amount and uniformity of flow, head, conditions affecting the cost of construction and transmission, use of exhaust steam and need of water for other purposes than power.

Second. Upon what the power is to be used for, whether for electric lighting and railway work, through most of the hours in the day with a variable load, for some use requiring a fairly steady load for twenty-four hours a day, or for running a textile mill or similar plant with a fairly steady load for about ten hours a day.

Third. Upon the market which can be served, whether it is secure and steady or must be built up and is somewhat unreliable.

The value of a privilege should be determined by comparison with the cost of producing power in such quantities and with such regularity as is required for the particular purpose for which it is to be used in a fairly economical manner at any place or places equally convenient for the transaction of the business under consideration. Sometimes the location is fixed, but oftentimes there can be a choice of locations.

In estimating the value of an undeveloped privilege, the steps followed are as follows:

(1) Determine the flow, including the effect of storage and pondage.

(2) Determine the net head.

(3) Determine the horse-power which can be economically developed and used each month in an average year.

(4) Determine the minimum flow and power, and from this the size of the supplementary steam plant required if the power is to be developed above the minimum flow.

(5) Determine the shortage of water power during such months as there is a deficiency.

(6) Estimate the probable cost of development of the water power.

(7) Estimate the probable cost of the supplementary plant, using steam, gas, oil, or anything which is best for the location under consideration.

(8) Estimate the yearly cost of running the water power and supplementary plants, including the fixed charges on both, to produce a combined power suitable for the purpose for which the power is to be used.

(9) Estimate the cost of a steam or other kind of plant, necessary to produce the power required.

(10) Estimate the yearly cost of running this plant, including fixed charges, to produce the power required.

(11) Subtract the cost of producing the power by water power and the supplementary plant from the cost of producing it by steam power, or some other method, alone. The difference, if positive, gives the apparent yearly saving by the use of water power. The apparent saving should be modified if necessary for location or any other thing affecting the value.

(12) Capitalize this difference at a rate which seems proper, and the result is the value of the privilege.

METHOD OF DETERMINING DAMAGES.

The damage has been defined as the difference in value of the entire property before and after diversion.

The writer has generally used the following method of determining the damage to an established property, due to the diversion of some of the water.

(1) Determine the flow, including the effect of storage and pondage, before and after the diversion.

(2) Determine the net head.

(3) Determine the horse-power which can be economically developed and used before and after diversion.

(4) The difference between the power used before and after diversion is the power diverted which causes damage.

(5) Estimate the additional yearly cost of running caused by the taking away of this power, of coal, attendance, and supplies.

(6) If any permanent power has been taken, that is, power which can be relied upon in the lowest flow of the stream, estimate the cost of a steam plant or portion of plant necessary to make good the amount taken in the dry month.

(7) Estimate the fixed charges on this cost of additional supplementary plant.

(8) Add the extra cost of running and additional fixed charges and the sum represents the extra yearly expense.

(9) This extra expense capitalized at a proper rate represents the damage.

Too much stress cannot be placed upon the importance of determining the flow of the stream under consideration. If careful gagings have been made extending over considerable time they are the most reliable information which can be had. If no gagings have been made, an examination of the watershed should be made to ascertain its character, all existing rainfall records in the vicinity should be collected, and an estimate made of the run-off. Assistance may be had by comparison of similar rivers, the run-off of which is known.

The amount of data on the flow of streams which is available is increasing each year, as careful records are being kept on many rivers by persons or corporations who are interested in these matters, and by the United States Geological Survey.

Mr. Clemens Herschel, in his paper wrote of the legal aspect of the subject, as well as the engineering. We abstract the following:

A full discussion of this subject necessarily treats of legal matters about as much as it does of hydraulic or other engineering. It must, indeed, be founded on a consideration of the fundamental rule of law, frequently quoted, that the measure of damage done a piece of real estate by the diversion from it of a certain quantity of water hitherto flowing through it is the difference between two market values of that piece of real estate, the one estimated or judged as of date before the taking of the water right; the other appraised as of date after that taking.

Two sums of money are to be attained or determined in the minds of the masters or other tribunal charged with the duty of awarding the damage done or suffered in such cases, and their difference is the sum of money to be awarded to the claimant. Nothing simpler, one is tempted to say at the beginning of such hearings; only a simple sum in subtraction to be performed. And yet no class of cases has probably given rise to greater wrangling or presented at times a more lamentable spectacle of the incompetency of a man to undertake the perfect administration of that one of the highest of divine attributes—the administration of justice.

Our comments may follow the order of words as above written in stating the rule of law to be followed, and we thus come upon the words "real estate."

(1) These cases deal with damage to a piece of real estate. They do not ordinarily deal, certainly not as far as the engineering expert is concerned, with damage done to the business carried on upon this real estate, nor with that done any particular individual. It is the real estate that is damaged, and it is this injury which is to be measured by a difference in its market values at two different dates.

(2) Diversion of Water. It may be hardly necessary to state that, inasmuch as all flowing water, as a rule, is held appurtenant to real estate, when some or all of this flowing water is prevented from reaching such real estate, an act of what is called diversion has taken place, and this causes the damage in such cases complained of.

(3) Market Value. A sum of money that can only be arrived at by the opinion of a properly constituted tribunal from evidence put before it, or generally by a consensus of opinion of men having knowledge of market values, that is, of the values of such property as it is bought and sold in a market that is neither stimulated nor constrained; that is, in a natural, open market, as between a party ready to sell and another willing to buy.

At first it might seem to an engineer as though the simplest way to compensate for the diversion of water from a piece of real estate would be by turning an equal quantity of water into the stream from some new source of supply, such as a storage reservoir to be constructed for that express purpose, and which would supply, when needed, water which had been stored out of freshet river flow; which not only was needed, but might even be detrimental to others, the claimant included, if not thus withdrawn and stored in times of high water. Especially does it seem strange to an American engineer that this method of paying for water diverted by the gift to the parties injured of a compensating reservoir, as it is called, is not followed in the United States, when he knows that for a hundred years or more this has been and yet is the accepted method in Great Britain.

Then, again, the state cannot authorize any one to "take property without just compensation"; and it is a settled principle of law in this country that a "just compensation" must consist of money paid over, and cannot consist of anything else. Every person has, moreover, the right of an appeal to a jury of his peers and countrymen at some stage of the proceedings, to say what amount would be a just compensation, and cannot be deprived of this, his right of appeal. So that though such compensating reservoirs have repeatedly been proposed, and in one instance—some sixty years ago, at the time of the construction of the first (the Cochituate) water works to supply Boston—were actually built, they could not be used to pay damages by substituting water delivered for water diverted.

It has been suggested that a city, by obligating itself to maintain and operate certain compensation reservoirs, could show that it had not diminished certain water rights, hence that no damage had been done, and there would be no damages to pay. But a jury would have to decree to that effect; a riparian owner has the right to have the water flow through his estate "without alteration," whether he were injured or not, and even were he benefited for the time being. In the United States he must pay damages in money if he wants them, and he generally does.

We have seen that a substitution of water for water diverted is unlawful and impossible in payment of damages in the cases we are considering. Equally so should be, but with uninformed tribunals is not always, the substitution of steam or other caloric or transmitted power for water power diverted. Such substitution offends against the rule of law quoted, which is based wholly on market values, and justly so, as will plentifully appear. Suppose, for example, that the water power taken were situated within the site of a storage reservoir, to be buried eventually under 50 feet or more of water. If now a computation were made for that case of any form of substitution of steam power, the whole of the water power being taken, it would result in a computed award made by the engineering expert that would have no proper relation to and might be twenty or thirty fold the market value of the real estate taken, either before or after the diversion of the water under consideration. That is to say, it would have no application whatever, to the case in hand; it would be wholly irrelevant and out of place for the expert to give it, and going further, he should know or be taught that such testimony is not aiding the court in its work. And if such testimony is wholly wrong or mistaken in one such case, because it does not instruct as to market values, the like testimony in other cases, if of no instruction in market values, is equally improper and may be grossly misleading.

Strictly speaking, all such cases require two distinct sets of experts, the one to measure the damage done in horse power diverted and similar damage done; the other, consisting of assessors, real estate agents, parties who have bought and sold mill property in the vicinage, etc., to appraise the value of the property before the diversion, and to appraise what that property was worth in the market since the acts complained of had taken place; which latter appraisal they may properly base on the results of the computations made by the first-named set of engineering experts.

In a paper by Mr. Richard A. Hale, he speaks of water rights when they are owned or controlled by several parties, and cites a number of such cases that are, or have been in dispute in New England. These water rights involved the amount of water obtained from the rivers at different seasons of the year, which naturally varied, and showed the importance of knowing the actual flow of the stream. Mr. Hale states that records should be kept to show the amount of water wasted, amount used for power, and the amount used for other purposes, as for boilers and for manufacturing.

This means the careful gaging of the water at various points and with such data collected the engineer is able to treat the subject more intelligently

Methods and Costs; Some Old; Some New.

Breaking Up Pavement Surface.—In one of our eastern cities a pile driver was used to break up an old asphalt pavement in order that the street might be repaved. The original pavement was cobblestone, and on this had been placed many washes of coal tar and asphalt. The contractor, at first, tried to remove the old pavement with a strong plow, drawn by a heavy road roller, but failed. He then mounted a pile driver frame about 15 ft. high on a heavy cart, which also carried a small hoisting engine used to raise the hammer. The latter weighed about 1,700 lbs., and had a chisel edge at the bottom about 14 ins long. After the hammer had fallen a few times on the pavement the cart was moved forward a foot or so, and the operation repeated. After a sufficient length of pavement had been broken gets too hot, or loses by evaporation. work by hand.

Apparatus for Extracting Asphalts With Solvents.—The following apparatus for extracting asphalts with solvents was designed by Mr. Adam Wirth, chemist of the Municipal Asphalt Plant of New Orleans, La., and was built by him with the assistance of a local electrician. It is described as follows in the report of the city engineer regarding the first year's operation of the plant: "The apparatus obviates the use of flame or gas through the use of electric light bulbs. It consists of a steel box 19 in. by 12 in. by 10 in., with movable top, in which are six round holes large enough to admit Wiley tubes. In the interior is a frame in which there are similar holes to steady, or support the tubes. This tray has a false bottom under which the electric wire connections are made to these sockets for the connection of 16 C.P. incandescent globes. Six samples can be simultaneously extracted in two hours' time by heat from two globes; the menstrum never ignites or

Electrically Operated Dredging Plant.—A dredging plant is now being installed to deepen the channel of the Jhelum river, in India, and in the construction of a large spillway to carry off flood waters. Owing to the scanty fuel supply in the vicinity of the work the dredging plant is to be operated by electricity, the power being obtained from a station which is being erected to supply the surrounding territory. The dredging plant will comprise a large dipper dredge with 4 cu.-yd. bucket, two suction dredges capable of raising and transmitting about 4,000 cu-yds. of sand and clay per 24-hour day, and two clam shell derricks for unloading the spoil from the scows which attend the dipper dredge. The whole outfit will be operated by 3-phase induction motors. Two floating 60,000 volt sub-stations, are being built for the dredging work. These sub-stations will contain the stepdown transformers and necessary switching apparatus, connection being made to the dredges by flexible cables supported on floats.

Data on Street Cleaning at Minneapolis.—The asphalt pavement of the city of Minneapolis, Minn., is swept by hand, using the Ross scraper according to the block system. Each man has from two to five blocks to keep clean. The sweepings are deposited in galvanized iron cans placed at street corners, from which they are removed by teams. The asphalt pavement is also swept by machine at night, and flushed whenever necessary. The wages paid per day are as follows: Teams, $4; men, $1.50 to $2. According to the annual report of the city engineer, the cost of hand sweeping for 1906, 31 men being employed, was $16,049, or 8.69 cents per square yard per year. The cost of cleaning, machine sweeping and washing was $9,276, or 5.02 cts. per square yard per year. A total of 11.65 miles of 27 ft. roadway, cost per mile per year for cleaning, $796.25; for sweeping, $1,377.57, or a total of $2,173.83. The cost of cleaning and sweeping the other paved streets was $43,014, or 3.33 cts. per square yard. This cost is for a yardage of 1,290,930 sq. yds., and does not include macadam and asphalt pavement. The cost of cleaning was 1.47 cts. per square yard, and the cost of sweeping was 1.86 cts. per square yard. In all 184,528 sq. yds. of asphalt pavement was cleaned and swept.

Scraper Work.—In placing the back filling for a dam, decked flat boats 4 ft. by 20 ft. by 100 ft. were employed, the puddle on them being unloaded with shovels and scrapers. Common steel drag scrapers were used at first, but were discarded for flat wooden scrapers, consisting of a piece of 3x12-in. plank 4 ft. long, beveled at the lower edge and fitted with two wheelbarrow handles as guides, and as drag scraper bail for the pulling rope. One barge of 40 cu. yds. capacity was unloaded in one hour with two of these wooden scrapers, using eight men on the barge and four men on the derrick boat below the dam. The derrick engine had two winch heads both of which were used. Another "home-made" scraper was used in an interesting manner in making a fill near Tacoma, Wash. In this case owing to steepness of the hill, the teams could not get to the dump, and accordingly the dirt was dumped on a platform at the top of the slope and pushed over by an ingenious arrangement. This consisted of the front wheels of a wagon, a long plank taking the place of the pole. To the front end of this plank was fixed another plank, the latter being shod with an iron plate. Whiffletrees were fastened to the axle and a team of horses used. When the horses moved toward the edge of the dump they pushed the plank and its scraper end before them, thus forcing the dirt off the platform. The plank was so balanced that a man sitting on the end extending behind the axle could by his weight lift the front end from the ground for another push when the team was backing.

Contract Labor Costs at Providence, R. I.—During 1906 2,263 miles of regular sewers were built at Providence, R. I., of which 1.751 miles were of pipe and .512 miles were of brick. The average depth of cut, nature of excavation and contract cost of labor per foot on the different sizes of sewers built during 1906 are given in the annual report of the city engineer as being as follows:

Nature of Excavation.	Average Depth of Cut. Feet.	Average Cost Per Foot.
6-in pipe[1]—Fine sand, dry	10.50	$0.45
6-in. pipe[1]—Fine sand, wet	10.50	.49
6-in. pipe[1]—Sand and gravel, dry	10.50	.41
6-in. pipe[1]—Hard pan, wet	10.50	.60
6-in. pipe[1]—Hard pan and rock	10.50	.35
8-in pipe[2]—Fine sand, dry	8.00	.40
8-in. pipe[2]—Fine sand, wet	8.00	.45
8-in. pipe[2]—Sand and gravel, dry	8.00	.40
8-in pipe[2]—Hard pan, wet	8.00	.45
8-in. sewer—Fine sand, dry	11.67	.90
8-in. sewer—Sand and gravel	11.67	.70
8-in. sewer—Filling, dry	11.67	.60
12-in. sewer—Fine sand, dry	12.00	.60
12-in sewer—Fine sand, wet	12.00	.85
12-in. sewer—Sand and gravel, dry	12.00	.62
12-in. sewer—Hard pan, wet	12.00	60
12-in sewer—Hard pan and rock	12.00	.35
15-in. sewer—Sand and gravel, dry	12.25	.75
15-in sewer—Hard pan, wet	12.25	1.00
20-in brick sewer—Hard pan and rock, wet	12.67	2.00
22-in. brick sewer—Hard pan, sand and rock, dry	12.83	.65
24-in. brick sewer—Sand and gravel, wet	13.00	3.00
30-in. brick sewer—Sand and gravel, wet	13.50	4.00
36-in. iron pipe—Mud, wet	14.00	6.50
70-in. brick and concrete—Sand and gravel, wet	18.00	8.00
70-in. brick and concrete—Sand and gravel, wet		30.00
84-in. brick and concrete—Mud, wet	14.00	8.00
84-in. brick and concrete—Sand and gravel, wet	20.00	20.00

---

[1] In drains to curb line. [2] In basin connections. [3] In tunnel.

The average cost of building each manhole was $10.65, each catch basin $11.07, and each extra inlet $9.00.

A meeting of delegates from various branches of labor throughout the Republic of Mexico is to be held early this year. It is planned at this convention by certain of the newly created labor leaders to organize a great union society similar to the Federation of Labor in the United States. At present railway workers and cotton mill operatives are the only branches of labor organized in the republic.

Iron and steel manufactures exported from the United States made their highest record in the calendar year 1907, the total being approximately 200 million dollars, against 63 millions in 1897, and 16¼ millions in 1887.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0559. **Cranes.**—Pawling & Harnischfeger, Milwaukee, Wis.

This company manufactures cranes of all types and devotes particular attention to the manufacture of cranes for heavy work. This pamphlet of 139 pages describes briefly the construction of these cranes, gives lists of standard sizes and hoisting and traveling speeds for various sizes. The descriptive matter is unusually good and the illustrations of actual plants in operation are excellent. The pamphlet is well worth adding to the engineers' catalog library.

No. 0560. **Series Luminous Arc Rectifier System.**—General Electric Co., Schenectady, N. Y.

The Series Luminous Arc Rectifier System developed by the above named company, permits the operation of direct-current luminous arc lamps from alternating current central stations at high economy and with extreme simplicity. It is described in this bulletin. The luminous arc lamp and the auxiliary apparatus consisting of oil cooled rectifier tube, constant current transformers and switchboard panels with the necessary control apparatus, reactance coils, etc., are described and their operation explained. In this lamp the upper electrode is a bar of hard drawn copper, and the lower electrode is made of specially prepared composition contained in an iron tube ⅝-in. in diameter by 8 ins. long. This lamp is claimed to be superior to other commercial lamps, in efficiency, distribution of light, color of light and low maintenance cost, and is particularly well suited to street lighting.

No. 0561. **Electric Drive in Cement Plants.**—General Electric Co., Schenectady, N. Y.

This bulletin describes the application of electricity to cement plants, and gives a large amount of information regarding the different processes and the apparatus used. A cement plant is kept in practically continuous production and the shutting down of any one machine must not affect the operation of the others. The direction and distance of the power transmission should not interfere with the most efficient layout which should be determined solely by the relative location of the quarries, the storage bins, the best available place for the machinery, and the space available for future growth. The raw material being a very small part of the production cost, a continuous and accurate record should be kept showing the amount of power used in each of the departments in order that the manufacturing cost may be maintained at a minimum. It is necessary to start the machines under overload and provide for short overloads during operation so that the driving power must give the best efficiency at normal loads with a large margin of overload capacity. To the above is added the most severe service conditions on account of the underskilled labor employed and the character of the material manufactured. The bulletin points out the reasons why the General Electric equipment will successfully meet the requirements. A list of cement plants using General Electric apparatus gives a number of the equipments already installed.

No. 0562. **General Electric Railway Controllers.**—General Electric Co., Schenectady, N. Y.

The above named company has designed a new line of cylinder controllers with improved magnetic blowouts which can be used on systems on which the voltage peaks reach 750 volts. At present three controllers known as the K-34, K-35 and K-36 are being built and are described in this bulletin. The K-34 controller is suitable for use with either two 150 H.-P. or four 75 H.-P. motors, the K-35 with either two 100 H.-P. or four 50 H.-P. and the K-36 with two motors only, each of 60 H.-P. or less. The K-34 and K-35 controllers are provided with bridge connections and maintain full current through all motors during the transition period from series to parallel, giving a smooth acceleration and reducing the strain on motors and gearing. A powerful magnetic field is produced by means of individual blowout coils and arc chutes which insures the extinction of the arc under all operating conditions and reduces the burning and repairs to a minimum. The bulletin gives the details of construction and dimensions of the different controllers.

No. 0563. **Engineering Instruments.**—Bausch-Lomb-Sagemuller Co., Rochester, N. Y.

This company manufactures a full line of engineering and astronomical instruments. These various instruments are described in this 100-page pamphlet. The larger part of the space is devoted to transits, levels and telescopes. Introducing the catalog matter there is an excellent essay on the construction of instruments. The pamphlet is well worth securing by engineers for the sake of having and reading this introduction.

No. 0564. **Flexible Roller Bearings.**—Hyatt Roller Bearing Co., Newark, N. J.

This bulletin showing the saving of power effected by substituting 30 Hyatt Flexible Roller Bearings on line shaft in press room of American Can Co., at Boston. Cuts showing roller bearings are given in bulletin.

No. 0565. **Gasoline and Kerosene Engines, Traction, Portable, Stationary.**—Hart-Parr Co., Charles City, Iowa.

This is a 40-page catalog describing and illustrating a traction engine that uses gasoline or kerosene as fuel. An oil cooler is used on the engine, hence no water is needed. This means a large saving, and allows of the operation in arid countries. In cold countries the absence of water is also an advantage, as the frost cannot effect the cooling jacket, when the machine is not in use. The various uses to which this engine is adapted are shown.

No. 0566. **Hoisting Engines.**—J. S. Mundy, Newark, N. J.

This is an 86-page catalog illustrating and describing various sizes and styles of hoisting engines for various purposes. Dredging machines and grab buckets are among the products of this company, also engines for derricks and cableways, and boilers for construction work.

Personals.

Mr. R. J. Edgerly has been appointed City Engineer of Albany, Ga.

Mr. Philip Prioleau has been re-elected City Engineer of Jacksonville, Fla.

Mr. James L. Tighe has been reappointed City Engineer of Holyoke, Mass.

Mr. David A. Hartwell has been re-elected City Engineer of Fitchburg, Mass.

Mr. Andrew Kelley has been reappointed Superintendent of the Sewer Department of Logansport, Ind.

Mr. T. P. Woodward has resigned as City Engineer of San Francisco, Cal., and is succeeded by Mr. Marsden Manson.

Mr. George W. Payne has been appointed Chief Engineer of the Missouri Southern R. R., with headquarters at Leeper, Mo.

Mr. E. S. Van Housen has been appointed Chief Engineer of the Tonopah & Goldfield R. R., and of the Bullfrog-Goldfield R. R.

Julian E. Smith, Chief Mechanical and Consulting Engineer of Armour & Co., Chicago, Ill., died recently at Magnolia Springs, Ala.

Patrick Coleman, of Coleman & Flozier, building contractors, Albany, N. Y., died Jan. 12, at his home in that city, aged 73 years.

Atlantic Bitulithic Co., George E. Tenney, President, has moved its offices from Spartansburg, S. C., to the Mutual Bldg., Richmond, Va.

Mr. T. J. Dolan, Secretary-Treasurer, of the Brotherhood of Steam Shovel and Dredge Men is on a trip to Panama, in the interest of his organization.

Charles H. Van Auken, for the past 14 years City Engineer of Cohoes, N. Y., died Jan. 19, at a hospital in that city from injuries sustained by being struck by a locomotive.

Mr. James B. Cox, formerly Chief Engineer of the Chicago Junction Ry. has opened offices in the Railway Exchange, Chicago, Ill., where he will engage in a consulting practice.

Mr. Abraham B. Samuelson has been transferred as Assistant Engineer from the office of the President of the Borough of Richmond to the Department of Bridges, New York City.

Mr. W. E. Gunn has resigned his position as City Engineer of Covington, Ky., to become engineer of a coal mining company. Mr. Harry G. Meiners succeeds Mr. Gunn as City Engineer.

Mr. C. H. Fisk has been appointed Chief Engineer of Maintenance of Way of the Colorado Southern, New Orleans & Pacific R. R., with headquarters at Beaumont, Tex.

Mr. W. H. Tarrant, for the past three years Chief Enginer of construction for the Illinois Traction System, has resigned. His duties will be assumed by R. McCalman, Engineer of Maintenance of Way.

Lieut. Col. Walter F. Fisk, Corps of Engineers, U. S. Army, has been detailed for duty as engineer of the 10th Light House District, relieving Col. Henry M. Adams, Corps of Engineers of that duty.

Mr. J. Walter Ackerman, for the past six years City Engineer of Auburn, N. Y., has opened an office in that city for the purpose of conducting a consulting engineering practice in general municipal work.

Mr. John A. Giles has been appointed City Engineer of Binghamton, N. Y. Mr. Giles was formerly connected with the Engineering Department of the Chicago & Northwestern R. R., engaged in track elevation work in Chicago, Ill.

Charles Hermany, Past President of the American Society of Civil Engineers, died Jan. 18 at his home in Louisvile, Ky. For the past 47 years Mr. Hermany has been Chief Engineer and Superintendent of the Louisville Water Works.

Lieut. Richard Park, Corps of Engineers, U. S. Army, has been relieved from further duty at Boston, under the immediate orders of Major Edward Burr, Corps of Engineers, and will proceed to Fort Flagler, Washington, for duty with Company B, First Battalion of Engineers.

Charles E. Conaway, organizer of the Buckhannon and Northern and Fairmont and Southern railroad companies, as well as coal combinations holding the majority of independent coal lands in northern West Virginia, died Jan. 25 at Fairmont, W. Va., after a three-day illness of appendicitis.

Messrs. F. A. Delano, President Wabash R. R., John M. Ewen, Consulting Engineer, Isham Randolph, Consulting Engineer, C. H. Conover, Alderman Charles M. Foell, Alderman Peter L. Hoffman and Charles H. Wacker have been appointed as members of the Harbor Commission of the city of Chicago, Ill.

Mr. Joseph Jacobs, former District Engineer of the U. S. Reclamation Service, at North Yakima, Wash., has been appointed to a position on the staff of Consulting Engineers, and Mr. C. H. Swigart has been appointed to the position of Tieton project engineer with personal charge of all matters relating to the work, acting also as engineer for the Sunnyside Project until another appointment is made.

St. George H. Cooke, C. E., Jun. Mem. Am. Soc. M. E., has opened offices in the Cambridge Bldg., Chester, Pa., where he will engage in a general engineering business. Mr. Cooke was Resident Engineer for the Tidewater (now the Virginian) Railway in southwestern Virginia for two years, prior to which time he was Chief Engineer for Roydhouse, Arey & Co., Contractors and Builders, Philadelphia.

Mr. George Weston has been appointed as the city's representative on the Board of Supervising Engineers in charge of the reconstruction of the street railway system in Chicago. Mr. Weston has been assistant to Bion J. Arnold, Chief Engineer of the board, and in his new position will succeed Mr. Charles V. Weston, his brother, who resigned to become president of the South Side Elevated R. R.

The following transfers have been made recently in the Engineering Corps of the U. S. Reclamation Service: Mr. J. A. French, Engineer, transferred from Sun River to Rio Grande Project; Mr. Roy M. Snell, Assistant Engineer, transferred from Huntley to Shoshone Project; Mr. L. R. Stockman, Assistant Engineer, transferred from St. Mary to Huntley Project; Mr. W. J. Ryan, Engineering Aid, transferred from Huntley to Shoshone Project; Mr. R. O. Hayt, Assistant Engineer, transferred from Huntley to Shoshone Project.

Messrs. H. G. Balcom and Wilton J. Darrow have opened offices as consulting engineers, under the firm name of Balcom & Darrow, at No. 314 Madison Ave., New York City. Mr. Balcom was formerly Engineer-in-Charge of structural design for the American Bridge Co. in New York and Pittsburg, and for the last three years has been structural engineer for the architects in the design of the new Grand Central terminal in New York. Mr. Darrow has been associated with him as assistant engineer in both of the above positions.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750

NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt

BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class matter April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

"The Probable End of the Ashokan Dam Controversy"—Engineering News—"Not Yet"—Engineering-Contracting 77

CONCRETE SECTION:

Cost of Constructing a Concrete Trestle and Three Concrete Girder Bridges with Abutments............78
Reinforced Concrete from the Contractor's Standpoint...............80
A Concrete Wall Form Clamp of Simple Construction...................83

EARTH AND ROCK SECTION:

The Use of a Water Jet to Increase the Speed of Rock Drilling and a Formula for Estimating the Amount of Water Necessary...................84
The Cost of Earth Excavation with Wagons During Winter Weather...85
A Contractor's Pail for Handling Heavy Materials..................85

ROADS AND STREETS SECTION:

The Detailed Cost of a Season's Work Laying Asphalt Pavements, Labor and Materials Itemized Separately..86
The Municipal Asphalt Repair Plant of New Orleans—Its Cost and Data on Its Operation.......................87
Specifications of the National Cement Users' Association for Cement Sidewalks 90

GENERAL ARTICLES:

Labor Cost of Building a High Power Transmission Line.................91

LETTERS TO THE EDITORS:

A Protest Against a Criticism of the High Labor Cost of Building a Reinforced Concrete Pipe by Day Labor—Comments on a High Cost for Excavation with Carts................93

"The Probable End of the Ashokan Reservoir Dam Controversy."—Engineering News—Not Yet—Engineering-Contracting.

A controversy is at an end when both sides have been heard. Thus far only one side has had the floor. The Board of Water Supply and its engineers has defended its position in awarding the Ashokan dam contract to the next to the lowest bidder at an increase of $2,300,000, urging, as its reason, that the lowest bidder would have suffered financial loss. The public has heard the debaters on one side only, and, due to the action of the corporation counsel of New York City in suppressing further hearings, the other side of this controversy has had no chance to defend its position.

Both the "Engineering News" and the "Engineering Record" have expressed editorial opinions in favor of the Board of Water Supply, without waiting to hear the other side. This was to be expected of the daily press, perhaps, but it hardly comes in good grace from journals that should know that the merits of more or less technical controversy can be judicially weighed only by a person who has heard all the evidence.

In justice to the engineers who were retained by the Commissioners of Accounts to investigate the award of the Ashokan dam contract, we purpose publishing a resume of the testimony that they would have given had not the corporation counsel stopped further investigation. Aside from doing this as a matter of justice to these engineers, we believe that their estimates and the records of actual costs upon which their estimates were based, will be of permanent value to all engineers interested in reservoir construction and in the cost of building earth embankments. We reserve the publication of these data until a later issue. At present we wish merely to give notice that the Ashokan dam controversy has just begun.

Here was a board, composed of three business men, who deliberately awarded a contract at 20 per cent in excess of the lowest bid, in spite of the fact that the lowest bidder is one of the wealthiest contractors in America. Can we imagine any one of these three business men nonchalently giving away some fifty fortunes because he feared that if he didn't do so there *might* arise some delay in the execution of the work?

Now this, remember, was a board of three business men selected by the business men of the city of New York, to supervise the expenditure of $160,000,000 on a water system. This board was nominally appointed by the mayor, but actually he is not responsible for it because the members were selected by the Chamber of Commerce, the Manufacturers' Association and the Board of Fire Underwriters.

At first blush, such a selection seems to take the Board of Water Supply out of politics; but, in fact, it merely substitutes a sort of irreproachable politics for responsible politics. This was well illustrated when the members of the Board of Water Supply, through their various friends, brought pressure to bear to secure their original selection, and subsequently, to defend their action in awarding the Ashokan dam to other than the lowest bidder. Furthermore, they carried on an educational campaign among the reporters, during the hearing before the Commissioners of Accounts, and if they did not play politics, from start to finish, the definition of the word needs revision.

The most important lesson to be drawn from this disgraceful blunder in municipal administration is this: *A board or commission having charge of work of an engineering nature should consist largely or wholly of engineers.*

Mr. J. Edward Simmons, the chairman of the Board of Water Supply, testified that he had given very little attention to the water supply project and that, on all engineering matters, he was obviously obliged to defer to the opinions of the board's engineers. Very good, but what did he do when the first really important *business* matters came up for consideration—the question of awarding a contract to other than the lowest bidder Did he use his own judgment then? No, for he and his fellow members of the board presented a set of questions to their engineers asking advice as to making the award; and here, too, they acted upon the recommendations of their engineers. Did they seek any outside engineering or business advice? No. Did they ask even one of their engineers if he had ever kept actual cost records of work analagous to the Ashokan reservoir? No, for, when these engineers were placed upon the witness stand, the astounding confession was wrung from the chief engineer, from the four assistant engineers who had made the estimates of cost, and from the three consulting engineers, that not one of them had ever kept any records of the actual cost of excavating earth with steam shovels! Yet they all admitted that the 7,000,000 cu. yds. of embankments for the Ashakan reservoir would have to be excavated with steam shovels. Just consider this admission in the light of the statement made by these same engineers that the bid of the lowest bidder was undoubtedly "below actual cost."

It has been said that the Board of Water Supply could not be expected to cross-examine its engineers on such matters. Why not? When a man employs an engineer for important private work he does not hesitate to cross-examine him as to the grounds for his opinions, especially on matters of cost. But this Board of Water Supply, devoid of engineering knowledge, did not even institute an inquiry to determine whether its engineers were devoid

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

of cost knowledge. It is in just such matters that a board composed of engineers would have made no blunder had it been investigating a report made by the engineers in its employ. Engineers are well aware of the fact that many engineers do not possess complete records of *actual costs,* however well informed they may be as to the general run of *contract prices.* Therefore, when one engineer states that a certain contract *price* is below actual *cost,* the most natural thing in the world for another engineer to do is to question the first engineer as to the experience or information upon which the statement is based. Therefore had the Board of Water Supply been engineers, they would certainly have demanded facts, and would not have been satisfied with fiats. To an engineer it looks as if they should have had business sense enough to do so anyway.

Following close upon the "end of the Ashokan dam controversy" has come announcement of the resignation of Mr. J. Edward Simmons, chairman of the Board of Water Supply. The mayor has requested the Chamber of Commerce to name his successor. It is perhaps expecting too much from such a body to hope that it may select a civil engineer, but the ordinary "business man" is as fit to be a member of the Board of Water Supply as a fisherman is to be demonstrator at a medical clinic. The problems before this board are engineering problems, involving no more of business knowledge than any capable engineer possesses; and often the engineering and business features are so interwoven that no man is able to pass intelligent judgment unless he is both an engineer and a business man.

The International Brotherhood of Steam Shovel and Dredge Men held its biannual convention in Chicago from Jan. 1 to Jan. 4. Reports showed that 1907 had been one of the most prosperous years that the organization has ever had. The secretary-treasurer's report showed $50,000 on hand. Members of the organization have been employed on steam shovel and dredges throughout the world at good salaries. Most of the shovel men employed at Panama are members of the brotherhood. An insurance plan was adopted, that will pay members from $1,000 to $1,500 in case of death or total disability. Officers were elected for the ensuing year, Mr. Charles Rees, of New York, being General President, and Mr. T. J. Dolan, of Chicago, Ill., being Secretary-Treasurer.

A total of 15,764,095 cu. yds. was excavated along the line of the Panama canal during the year 1907. Of this amount 10,959,967 cu. yds. were removed by steam shovels, and 4,804,128 cu. yds. by dredges. From the Culebra division alone 9,177,130 cu. yds. were removed, all except 207,558 cu. yds. being taken from the canal prism.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Cost of Constructing a Concrete Trestle and Three Concrete Girder Bridges With Abutments.

The reinforced concrete trestle and the three bridges with concrete abutments that are referred to in this article were constructed near Easton, Pa., by Mr. M. P. McGrath, general contractor, of that place. The contractor or his engineer, Mr. J. F. Mooney, supervised the work so that while one man was employed nominally as a foreman and received $2.75 per day, he worked like the other laborers; generally he was charged to placing or finishing. being staggered with those of the other rail. This construction gave excellent results in operation and saved some 6 ins. in height over the ordinary cross-tie construction. The remaining structural details and dimensions of the trestle are clearly shown by Figs. 1 and 2.

The wages paid on this trestle and also on the bridge construction described later, were as follows:

Laborers, per 10-hour day	$1.50
Blacksmiths, per 10-hour day	2.00
Engineman, per 10-hour day	1.70
Carpenter, per 10-hour day	3.00
Foreman, per 10-hour day	2.75

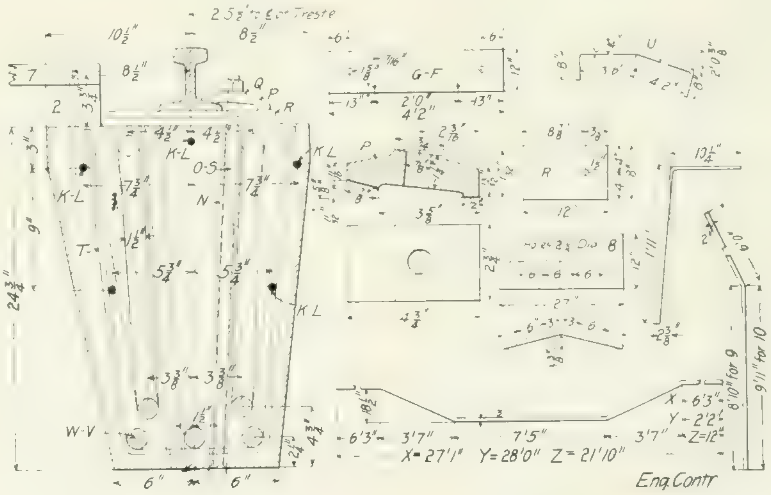


Fig. 1—Details of Girder Rail Fastenings, Etc., Reinforced Concrete Trestle.

The costs given are actual costs except for the form lumber, which had been used before and the cost of which was approximated. The costs are given separately for each structure.

Coal Trestle.—The trestle was designed as a coal trestle and was constructed as shown by Figs. 1 and 2 except that the bents instead of being made solid, were built with a 4 x 8 ft. opening in each to permit the coal to flow more readily. There were 8 bents and two abutments and the trestle was 114 ft. long. It was designed to carry the rails directly on the girders without cross-ties, so that the girder reinforcement was made quite heavy as is clearly shown by the drawings. It will also be seen that the rails had their bases partly embedded in the girders and were fastened by chairs. The chairs were of cast iron and were held by bolts extending down into the girder and secured under the lower reinforcement bar. The chairs were spaced 2 ft. apart, those of one rail

The location of the trestle being almost flush against a railway embankment and it being necessary to locate the stock piles some 150 ft. from the mixer, made the cost of wheeling the materials high. The mixer was set up at the center point of the trestle and discharged into barrows which were hoisted by a pole and yard arm. The pole was provided with a yard and had a three-quarters swing. A rope passing over a pulley at the end of the yard arm was provided at one end with a three-line sling provided with a hook to attach to the wheel and two rings to slip over the handles. This rope hoisted the barrows to the top of the trestle by means of a horse hitched to the free end. The concrete used for the reinforced girders was a 1-2-4 mixture, the other parts of the trestle were made of 1-3-6 concrete in which were embedded stones ranging from the size of a man's head to the size of a half-barrel: these rubble stones were thrown into the forms in 1½-ft. layers. The total amount of concrete in this trestle was 116 cu. yds. and its cost was as follows:

Materials.	Per cu. yd
1.069 bbls. cement at $1.24	$1.325
0.631 tons sand at 70 cts	0.442
1.11 tons stone at $1.25	1.387
131½ lbs. steel at 2 cts	2.630
Lumber ($112.63 charged up)	0.971
Total materials	$6.755
Labor and supplies:	
Making and erecting forms	$1.21
Handling sand	0.180
Handling stone	0.175
Mixing concrete	0.184
Placing concrete	0.300
Finishing concrete	0.103
Miscellaneous	0.246
Total labor	$2.398
Total labor and materials	$9.153

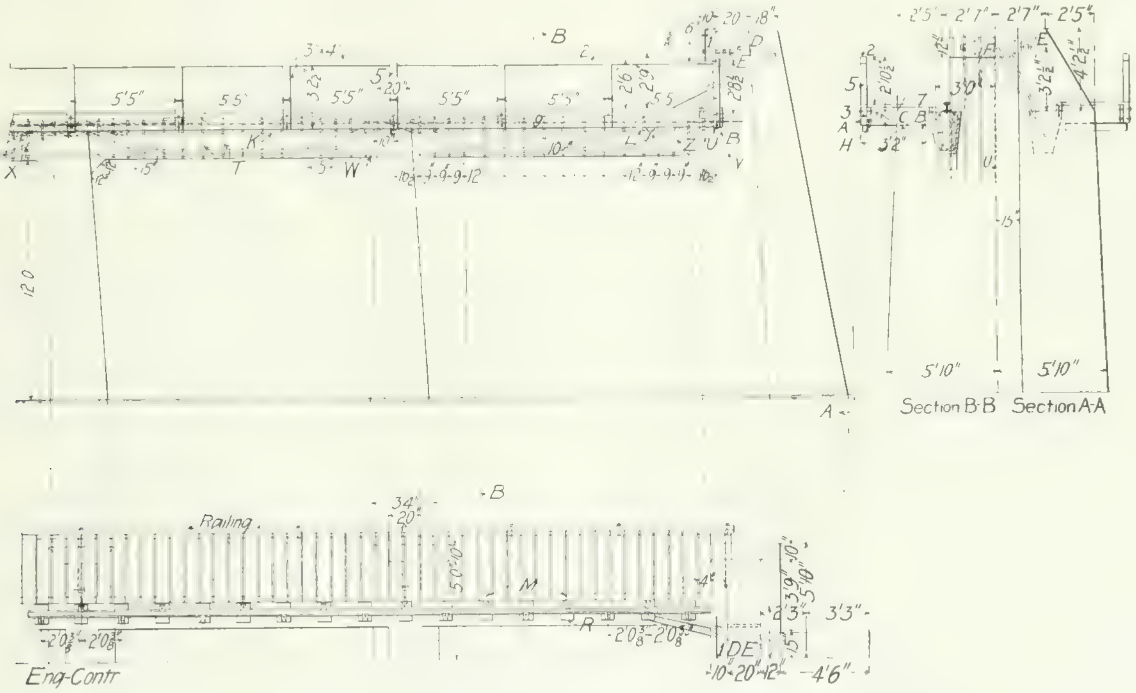


Fig. 2—Part Plan and Sections of Reinforced Concrete Coal Trestles.

In the item miscellaneous were included blacksmith's work on reinforcement, handling cement, coal, oil, etc. As will be noted the cost of reinforcement is distributed over the whole structure 116 cu. yds. of concrete; to be strictly accurate, the total 15,250 lbs. of reinforcing metal should be divided into the volume of concrete in the girders which, figured from the drawings, was approximately 24 cu. yds. This gives the great weight of 635 lbs. of reinforcement per cubic yard of concrete.

Bridge No. I.—This structure had a clear span of 10½ ft. and consisted of two girders, one under each rail, with ends embedded into concrete abutments with wing walls. The girders were 3 ft. deep, 2 ft. wide on top and 1½ ft. wide on the bottom and each was made of 1-2-4 concrete reinforced by five 1½-in. round bars, three straight and two bent, with stirrups every 1½ ft. The abutments were made of 1-3-6 concrete. Conditions were favorable construction. As in the trestle rubble stones were incorporated in the abutment concrete; some cinders were also used and their cost is included in the cost of handling the stone. The bridge contained altogether 102 cu. yds. of concrete. The costs were as follows:

Materials.	Per cu. yd.
Cement	$1.204
Stone	1.688
Sand	0.444
Reinforcement	0.098
Lumber	0.383
Total materials	$3.877
Labor and supplies:	
Forms	$0.470
Handling stone	0.175
Handling sand	0.077
Mixing concrete	0.100
Placing concrete	0.176
Finishing concrete	0.094
Miscellaneous	0.224
Total labor	$1.325
Total materials and labor	$5.202

The item miscellaneous includes hauling cement and water, work on reinforcement and coal. As in the trestle, the unit cost of reinforcement is got by dividing the total cost into the total yardage of concrete value as only the girders were reinforced.

Bridge No. II.—This bridge had a clear span of 16 ft. and was 13 ft. high, and like the bridge just described consisted of two girders with ends embedded into concrete abutments. The girders were 22 ins. deep, 2 ft. wide on top and 1 ft. wide on the bottom. Each girder was reinforced with five 1¾-in. round rods, three straight and two bent, without stirrups. The ties were fastened to the girders by embedded anchor bolts. The costs of materials changed somewhat from those given for the trestle and bridge No. I. The cement cost $1.54 per barrel, and the stone (crushed on the ground) cost 73 cts. per ton. Rubble stones were incorporated in the abutment concrete as in the work previously described; this stone had all to be collected by men and teams and this fact is reflected in the high unit cost of handling stone. The mixer was located so that its discharge chute overhung and discharged directly into the forms for one abutment. To reach the further abutment an ordinary coal chute was provised and the concrete chuted directly into place. The bridge contained 98 cu. yds. of concrete which cost as follows:

Materials.	Per cu. yd.
Cement at $1.54	$1.596
Stone	0.814
Sand	0.453
Reinforcement	0.176
Lumber	0.316
Total materials	$3.355
Labor and supplies:	
Forms	$0.520
Handling stone	0.236
Handling sand	0.180
Mixing concrete	0.073
Placing concrete	0.157
Finishing concrete	0.092
Coal and water	0.041
Handling cement	0.078
Total labor	$1.377
Total materials and labor	$4.732

It will be noted that the cost of handling the stone for this bridge ran high because of the teaming referred to above. Reinforcement is charged into the total yardage as in the structures previously described.

Bridge No. III.—This bridge was built for the passage of farm wagons of 5 tons capacity. It had a clear span of 17 ft. and was 15 ft. wide and 17 ft. clear height. The floor consisted of four 12 x 6 in. girders carrying a 6-in. floor slab. The concrete was a 1-3-6 mixture throughout and was mixed by hand. The concrete was made with a broken tile aggregate attained from a nearby tile works at the cost of handling only. This tile was very easily broken and left a rather poor finish to the concrete. There were 107 cu. yds. of concrete in the bridge and it cost as follows:

Materials.	Per cu. yd.
Cement	$1.594
Sand	0.459
Reinforcement	0.127
Lumber	0.280
Total materials	$2.460
Labor and supplies:	
Forms	$0.41
Handling tile	0.692
Handling sand	0.112
Handling cement	0.105
Mixing concrete	0.413
Placing concrete	0.341
Total labor	$2.077
Total materials and labor	$4.537

In noting these costs the very heavy cost of handling the broken tile aggregate will be observed; on the other hand this aggregate cost nothing itself. The lumber charge is only that for new lumber, the old lumber that was reused was not charged in. The cost of sand was 94 cts. per ton.

A check-weigher at the South Normanton coal mine in Derbyshire, England, according to a recent consular report, has invented a method of blasting which is claimed to much reduce the liability of accidents by ensuring the firing of every charge. It is thus described: The end of a tube with a loose central needle is inserted into a cartridge of explosive material, and the cartridge with the tube and needle are placed in the prepared shot hole. The hole is then rammed, after which the needle is withdrawn from the tube, and the detonator, attached to a suitable carrier, is then passed through the tube into the space left in the explosive by the withdrawal of the needle. The detonator is coupled to the battery and fired; but if from any cause the explosive is not fired, or the detonator misses fire, it can be withdrawn and another detonator attached to the carrier and placed to the explosive, as in the first case.

Africa has 17,000 miles of railway.

Reinforced Concrete From the Contractor's Standpoint.[*]

BY HENRY H. FOX [†]

The general problem before the contractor in reinforced concrete is to make the best possible reinforced concrete at the least possible cost. The first part of this discussion will deal with methods to be followed and precautions to be observed in order to attain excellence of workmanship; the second part, with methods to be followed in order to attain this excellence cheaply.

To make the best possible reinforced concrete it is necessary:

(1) That the forms should be strongly built, smoothly finished and as nearly as possible water-tight, and should be left in place until the concrete is self-supporting.

(2) That the reinforcement should be designed to relieve the concrete of all stresses which concrete cannot safely withstand, and to be amply protected from fire and weather by concrete on all sides; that the reinforcement should be so securely fixed in place before concreting that the concreting will not disturb it.

(3) That the concrete should be mixed and placed in such a way that the final product will be homogeneous and without voids.

First—Forms should be built of matched and dressed lumber and should be greased to make them part easily from the concrete. Their construction will be described in some detail in the second part of this paper. The length of time which should be allowed to elapse before removing forms depends upon two factors—the weather, and the load to which the member in question will be subjected upon removal of the forms. The fact that the concrete sets more rapidly the warmer the weather needs no elaboration. It is however never out of place to utter a warning against taking risks with concrete in cold weather. I suggest that very valuable information might be obtained from compressive tests on a series of concrete blocks, No. 1 being kept at a temperature of 30° for one month after making, and being then tested; No. 2 at 35°; No. 3 at 40°, etc. Scratching concrete with a knife gives one a rough idea of its strength, providing one scratches often enough to become thoroughly familiar with the behavior of concrete under the knife. With regard to the second factor influencing the time which should elapse before removing forms, it may be said in general that the nearer the load to be sustained approaches the load for which the member was designed, the longer the forms must remain. Thus the forms for an overhanging cornice should remain in place longer than the forms for almost any other member, because the dead weight of the cornice is a very large percentage of the total weight which it is designed to carry. By similar reasoning, roof forms should remain longer than floor forms; floor forms longer than column forms; column forms in the top story of a building longer than column forms in a lower story, and column forms in general longer than footing forms.

It is very important that forms should be so designed that the column forms may be removed without in any way disturbing the supports of the beams and girders bearing on these columns. In this way a defect in a column may be detected and remedied before any load is brought to bear upon the column. In removing beam and girder forms, the posts should be removed from only one beam or girder at a time, and as soon as the form for this beam or girder is removed the posts should be immediately replaced. By this procedure danger of failure of concrete through poor workmanship is much diminished, as a defective member is supported by the members on either side of it until the defect may be remedied. The practice of removing all the posts under a floor at the end of a given period—one, two or three weeks—without pausing to remove the forms one at a time, examine the workmanship and replace the posts, cannot be too strongly condemned, both because of the possibility of defective workmanship and because the concrete floor, even if not defective, may not be strong enough to carry, in addition to its own weight, the weight of the one or two floors which may, by the time the forms are removed, have been constructed above it.

There is less danger in taking down column forms, when the concrete is 36 hours old and floor forms when the concrete is five days old, if the posts of each member are removed separately, and as soon as possible replaced, than there is in knocking out all the posts under a large piece of floor in three weeks. Legislators who frame laws aiming at safety in concrete construction should bear this in mind.

It is of the first importance that the foreman in charge of removing forms should be of a high order of intelligence, and a man who can be relied upon to obey orders literally, for the reason that a mistake on his part is more likely to cause damage to life and property than a mistake on the part of any other foreman.

Second—Reinforcement should be designed to take all tensile stresses which occur in a reinforced concrete structure. Whether the reinforcement shall carry shearing or compressive stresses depends upon the conditions in each particular case.

Tensile stresses occur horizontally in the bottoms of beams, and, in the case of continuous beams, in the top of the beams over supports. They occur diagonally in every other part of a beam except the top. The horizontal tensile stresses are taken by horizontal bars. The diagonal tensile stresses are best taken—as most authorities are now agreed—by diagonal bars. As the horizontal tension is less at the end of a beam than in the center, it is obvious that if there are two or more bars in a beam, one of the bars which takes the horizontal stress at the middle of the beam may be deflected to take the diagonal tension near the ends of the beam, and in the case of continuous beams the horizontal tension over the supports. Thus are developed the familiar bent bars now in common use.

---

[*] Paper read at the annual convention of the National Cement Users' Association, January 20-25, 1908.

[†] 11 Broadway, New York, N. Y.

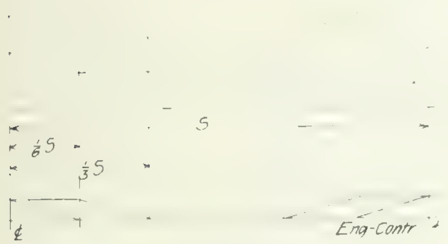


Fig. 1.

Shearing stresses occur chiefly near the supports of beams. The vertical shear is generally taken partly by the concrete, partly by the tension bars which run over the support. Horizontal shear is taken partly by the concrete, partly by the diagonal tension bars and partly by stirrups.

Compressive stresses occur chiefly in the tops of beams and in columns. Compression in beams is almost always taken by the concrete alone. Compression in columns is taken partly by the concrete, partly by the vertical steel bars. Vertical compression in columns induces a horizontal tension or bursting stress. Concrete is so weak in tension that a concrete column without reinforcement usually fails in tension, either by bursting or by buckling. The tendency to buckle is best resisted by vertical steel bars; the tendency to burst by steel hoops or a steel spiral near the surface of the column.

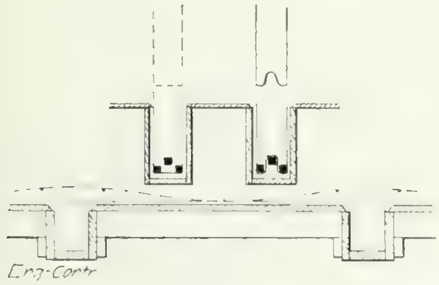


Fig. 2.

Figure 2 shows a method of holding steel in place in a typical beam containing three tension bars. Note that the stirrups touch the forms only in two points and are, therefore, well protected against fire. The stirrups should not be relied upon to support the tension bars in place, but hangers should be used. As these hangers are of no further value after the concrete is in place, the fact that they are supported directly on the forms and are thus not fireproofed is of no importance. The middle portion of tension bars in beams and girders is thus held in place by hangers; the ends are held in place by being laced with wire to one another and to the vertical reinforcement in the columns. The bars in the floor slab are supported off the forms, as follows: In order to obtain continuous action over beams every alternate tension bar in the floor slab is sprung up where it crosses a beam, being supported at the edge of each beam by a short piece of band iron about 1½ ins. narrower than the thickness of the floor slab, and bent to an angle of about 60°, so that it will stand on edge by itself. In the middle of each span a bar runs at right angles to the tension bars, on top of the tension bars, and is held at any desired distance above the floor by staples into the floor cover and by the lifting tendency of the tension bars which are sprung up over the beams. The other tension bars are then raised from the floor by lacing them with wire to this central bar.

To insure fireproofing in columns, four sticks are used in tamping the concrete in columns, and these sticks are run down one on each side of the column between the hoop or spiral reinforcement and the form, thus insuring an amount of fireproofing equal at least to the thickness of the stick. The vertical reinforcement is placed inside the hoop or spiral reinforcement.

Commercial methods of bending steel to the shapes above mentioned will be considered in the second half of this paper.

Third—How to mix concrete well, by hand or by machine, needs no discussion. How to place it well is another matter. In the case of floors the trick is simple. Concrete should not, unless it is absolutely necessary, be dumped from a wheelbarrow directly against the form, but should be dumped on the soft concrete already in place. The mortar, flowing more freely than the stone, keeps always ahead of the mass, and stones falling in this mortar find a perfect bed; whereas if a barrowful of concrete is dumped into a dry beam the stones often become jammed between the forms and the steel and form a pocket into which the mortar does not enter.

A few years ago I visited a very large concrete job on which the old-fashioned specifications were in force—that concrete must be placed in thin layers. Nobody on the job seemed to know the trick of placing concrete properly, and consequently the contractor, in order to obtain smooth workmanship, was placing an inch or two of clear mortar in the bottom of all beams and girders before filling them with concrete. The expense entailed by this may be imagined.

The place to dump the first barrowful of concrete when starting a piece of floor is either on the floor slab or in a column. Fig. 3 will show the reason.

This slide illustrates the action of concrete in a beam being filled. It also illustrates a condition in which a beam should not be left for any length of time. As long as the mass is kept moving it will be homogeneous; but if it is allowed to set in this shape two evil results will follow: First, the cement and water, the most fluid part of the mass, will flow forward, leaving behind a layer consisting chiefly of sand, with which the concrete, subsequently placed, will not mix, and which has very little value as fireproofing; second, the scum which rises to the surface of wet concrete contains the finest dust present in the sand and stone, and therefore sets with a very smooth, glassy surface to which fresh concrete will not adhere. This joint, therefore, if work is stopped on it long enough to allow the scum to harden, will be very weak in shear and tension.

Fig. 3.

Figure 5 shows one way of designing a beam on the outside of a building to make water-tight the joint between the beam and the wall resting on it, and between the beam and the window beneath it.

In concreting columns it is necessary to proceed slowly at the bottom of the column and to tamp the first foot with great care. After the mortar flushes to the surface over the entire section of the column, there is little danger of voids being left in the part of the column above the first foot, if a sufficiently wet mixture is used. Walls should be similarly handled.

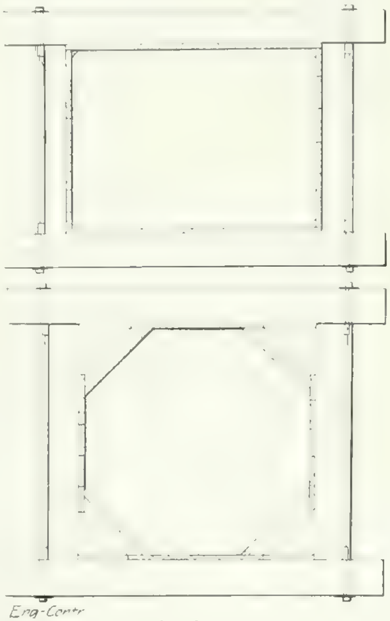


Fig. 4.

Economical methods of handling forms, steel and concrete will now be considered.

Figure 4 shows sections of two typical

column forms. The exterior column is usually made square for architectural reasons. The interior column is octagonal, partly for architectural reasons, partly to save concrete. This saving is due to the fact that in a column reinforced with a spiral the concrete outside the spiral is not figured as adding compressive strength to the column; and therefore, if this column is square, the concrete in its four corners is wasted. Of course, the question arises whether the concrete saved pays for the additional carpenter work. As a rule, the two items almost counterbalance each other, so that the matter of appearance is more important than the matter of economy.

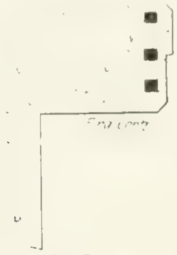


Fig. 5.

These two sides of the columns are held together, as shown, by bolts; the opposite two sides by hardwood wedges between the bolt and the form, as close as possible to the end of the bolt. It will be noticed that in some cases the sides are made up of narrow strips. This is to facilitate the reduction in size of the columns from floor to floor. In warm weather there is no need of having more column forms than one complete set for one story, even when work is proceeding at the rate of a story in five or six days. In a ten-story building each column form is then used ten times, once in each story. Each of these narrow strips represents the reduction in diameter of the column from one story to the next. It is of course much cheaper to have these strips ripped beforehand in the mill than to have a carpenter rip off a strip for each successive story. The outside and inside of the exterior column form are not made up of narrow strips for the reason that exterior columns are usually the same width from basement to roof. To reduce the section of an exterior column only the thickness is reduced.

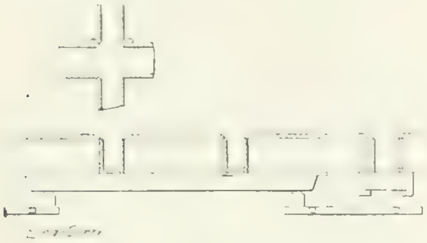


Fig. 6.

Figure 6 shows the section of a typical floor. Note the method of supporting this member, the "girder bottom," on the horizontal clamps of the column form, and of supporting the beam forms on the girder bottom. Thus all the forms for a floor may be erected before any posts are put in. The posts are put in at any time after the beams are in place, without any lateral bracing whatever. In this way time and labor are saved. If 2-inch lumber is used for beams, the beams must be at least 2 inches shallower than the girds, in order to allow the beam form to be supported by the girder bottom.

This wedge-shaped piece is a "key" inserted to facilitate removal of form. The flat cover or panel which supports the floor slab is better than the box-shaped type, for the reason that any slight errors in line are taken up at the junction between cover and beam side, and a slight variation in this dimension is not conspicuous.

In removing forms the column forms are first removed. As has been said, the details about the tops of column forms should be so designed that they may be removed without in any way disturbing the beam and girder forms. Next, the posts are taken from under the girder. The girder bottom then drops. The nails are drawn from the key, which is nailed only to the girder side, the key is knocked out, the posts are taken from under the beam, the so-called "spreaders" are knocked from under the cover, and the beam form comes down in one piece. The girder sides, which are beveled at the ends, come out easily, as does also the cover, which is beveled on all four edges.

Figure 5 shows a method of supporting exterior column forms and shows some typical exterior wall forms.

A circular saw will effect economy in a building of moderate size, especially if the same engine or motor may be used to run the saw and other machines, such as a boring machine, a steel hoist, a grindstone or a shear.

In warm weather, with a complete set of forms for one story, a speed of construction of one story in eight or nine working days may be attained. With one complete set of column forms and a set and a half of floor forms a speed of a story a week may be attained. The size of the building in plan makes very little difference.

In the discussion of methods of handling steel the first question is, To what extent shall machinery be used in bending bars? At the present day there is, so far as I know, no machine which bends tension bars for beams and girders as economically as they can be bent by hand. For one thing, the cost of handling the bars to and from the place of bending is a large percentage of the cost of bending, and this cost would remain the same in either case. The decisive reason is, however, that the number of possible shapes of bent bars is infinite; the number of different shapes required in one building is very large, and a machine to be efficient would have to be capable of rapid adjustment from one shape to another and consequently complicated.

A machine can be made to bend stirrups and hangers economically, as they are light and of smaller variety than tension bars.

In making spirals two processes are involved: First, bending the steel—which is usually in the form of wire—to the required diameter; second, spacing the coils to the required pitch and fastening them so rigidly to longitudinal bars that this pitch will not be disturbed in handling. The first process is accomplished more economically by machine, the second usually by hand.

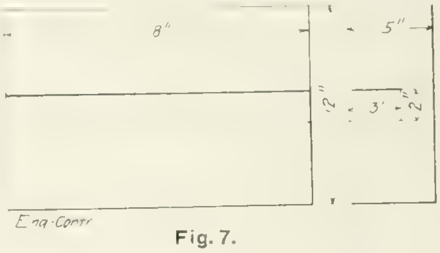


Fig. 7.

Figure 7 shows a simple form of block for bending beam and girder bars. The block is attached rigidly in a horizontal position to a bench, the bar is dropped in the slot, a piece of extra heavy pipe is slipped over the end of the bar, and two or three men bend it to the required angle. This bending block may be made of an iron plate with two angles riveted to it back to back to form the slot. Stirrups when bent by hand are bent on such a plate the angles of course being small and only far enough apart to admit a bar of the size used for stirrups. A block for bending stirrups may be made small enough to slip into the pocket.

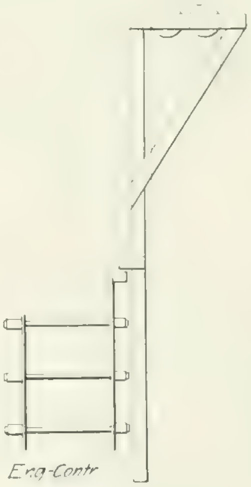


Fig. 8.

Spirals are made up on a simple wooden reel, the requisites of this reel being that it should be rigid, adjustable for different diameters and collapsible to allow the finished spiral to be easily slipped off.

Whether power other than hand-power should be used to hoist the reinforcement to the floor where it is to be used depends upon the height of the building and the quantity of steel on each floor. The wages of an engineer for one day will pay for a great deal of hoisting by hand. In case the job is large enough to warrant installing a power hoist, a convenient form of derrick is shown in Fig. 8. It is of course necessary to have steel on a floor before concrete; therefore, the necessity of having a derrick light enough to be attached to the forms before they are filled is apparent. The strain of the fall-rope on the derrick pulls the column out of plumb less than an inch, and this displacement is easily recovered with a guy-rope and turn-buckle before concreting.

Figure 9 shows a typical layout of concrete mixer and hoist. You will note that no hopper is shown for charging the mixer. The question whether or not a charging hopper shall be used depends on several things. Unless it is possible to set the mixer several feet lower than the storage of sand and stone, some kind of hoist must be arranged to fill the hopper. This means additional machinery and generally the wages of an additional engineer. In New York City one of the obstacles to setting a mixer much lower than the storage piles is tide-water. Basement floors in New York are usually laid as near tide level as possible. During the construction of a building the basement is used for storage of sand and stone, and in order to set the mixer much lower than the basement floor an expensive water-proof pit must be constructed. A charging hopper of course makes it possible to charge the mixer more rapidly; but the fact should be borne in mind that no time is saved by charging the mixer more rapidly than the concrete can be taken away. The mixer should be set so low that the wheelbarrows run on a level grade or slightly down-grade in feeding the mixer.

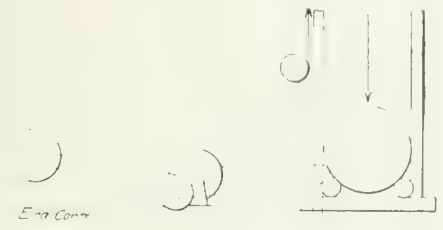


Fig. 9.

In the case shown here the mixer is driven from the shaft of the hoist, and this shaft, from the motor.

Figure 10 shows the side view of the framework in which the bucket runs. How large a mixer to install depends upon the rate at which concrete is to be used. An ordinary mixing plant will turn out easily forty batches per hour, and may be made to turn out sixty batches if the hoist is designed to take it away as fast as that. In laying out a schedule for concreting attention should be given to the fact that speed makes for economy, for the reason that there are several special men in a concrete gang whose wages remain the same regardless of the amount of concrete placed. These are an engineer, a foreman and at least three laborers—namely, one throwing water into the mixer, one dumping the mixer and one loading the wheelbarrows up on the floor. The sum of their wages at New York rates is $16.60 per day. If eighty yards are mixed in a day these men add to the cost of mixing about 20 cents per yard; if 160 yards are mixed they add only 10 cents per yard.

Fig. 10.

With regard to plant in general, it may be said that many contractors make the mistake of installing more machinery than is warranted by the quantity of material to be handled by this machinery. For example, on a piece of concrete work containing about 1,500 cubic yards of concrete, which I once visited, $10,000 had been spent in plant before a yard of concrete was mixed. At least $8,000 of this was wasted; for although the unit of costs may have been made less than they would have been if more primitive methods had been employed, the total costs, including the cost of installation, were much greater. The machinery did not have enough to do to pay for itself. To determine correctly the kind and quantity of machinery to use, a contractor must have both good judgment and a thorough knowledge of costs.

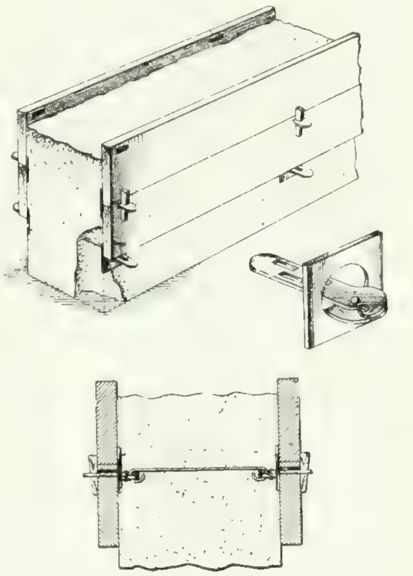
A Concrete Wall Form Clamp of Simple Construction.

The accompanying sketches show a combined wall form clamp and tie which is simple in character and should prove useful in many places. As illustrated this clamp serves as a plank holder as well as a wall form tie, thus doing away with studding or bracing; it is obvious, however, that the device will serve also as a wall form tie when studding is used. The "clamp" proper, which is the essential part, consists, as will be seen, of a jaw pivoted like a pair of pincers which grasps the looped end of the tie wire, and of a tail slotted to receive steel wedges which brace against a washer. The form boards are slotted, as shown, to receive the clamps. The arrangement of the clamps, ties and form boards is clearly shown by the accompanying illustrations. The clamps and ties are made by Charles Dietrichs, Little Ferry, N. J., who gives the following explanation of their use:

For the average two-story house, the ground dimensions of which are about 22x30 ft., where the ordinary 10 or 12-in. walls for foundation are used, about 200 of the tie wires for use with the Dietrichs clamp are required and about 500 wires of the 8-in. size for the upper stories, or a total of 700 wires for the complete work will be found ample. This estimate of quantity of wires required is based on the spacing of wires about every 4 ft. and this will be found a sufficiently short distance to allow of procuring rigid forms.

It is generally found most convenient to build the forms three boards high throughout the entire ground size, and this method will require, for a house of the dimensions specified, approximately 150 to 200 clamps. The clamps—unlike the tie wires—may be used over and over again, and their cost, therefore, should not be considered a part of any one job, as they are indestructible and represent an investment for continued use.

On the basis as above estimated, the cost of the tie wires is approximately $5 and the cost of 200 clamps $70, making a total cost—aside from the lumber required with the use of these clamps—of $75, and the only portion of this expenditure which should be charged to any one job is a very small percentage of the cost of the clamps and the cost of tie wires which are imbedded in the wall. If 24- used as forms for both foundation and in. panels, instead of 12-in. boards, are upper stories, it will reduce the number of tie wires, as well as the number of clamps required, by from 30 to 50 per cent.



Wall Form Clamp and Wall Tie.

The Isthmian Canal Commission is now calling for bids for Portland cement for use in the construction by the Isthmian Canal. The total quantity to be used is 4,500,000 bbl. more or less, and the consumption will be at the rate of about 4,500 bbl. per day.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Use of a Water Jet to Increase the Speed of Rock Drilling and a Formula Estimating the Amount of Water Necessary.

There is probably no kind of rock that can not be drilled more rapidly with the use of water jet for removing the sludge than without a jet. Even upon the gneiss of New York City a water jet has proved very effective (Gillette's "Rock Excavation," page 290). A water current of proper volume washes away the sludge and rock chips from the bottom of the drill hole, and leaves a clean face of rock for the bit to strike. But the question that has puzzled many an engineer and contractor has been: What volume of water is necessary to lift the sludge and chips vertically? In this article we shall give the first rational solution of this problem that has ever appeared in print. But, before giving the solution of the problem, we shall give the results of that solution in the form of a rule that may be readily applied in any given case of rock drilling.

Rule: To ascertain the number of gallons of water per minute required to remove sludge from a drill hole, by means of a vertically rising current of water, square the diameter of the drill hole at its mouth (the diameter being measured in inches), multiply by the square root of the diameter of the largest grain or particle of sludge (also measured in inches or fractions of an inch); and then multiply by 7.

Example: A drill hole is 2½ ins. diameter at its mouth, and the largest grain of sludge (that is, the largest chip of rock) is ¼ in. diameter. How many gallons of water must a water jet deliver per minute?

According to the rule, square 2½, and the result is 6¼. Take the square root of ¼, which is ½. Then multiply the 6¼ by the ½ by 7, and the product is nearly 22 gallons per minute.

It will be noted that the quantity of water required increases as the square of the diameter of the hole, so that doubling the diameter of a drill hole (at its mouth) increases the amount of water four times. It will also be noted that the amount of water required increases as the square root of the diameter of the largest grain or chip of rock to be elevated. Hence a chip four times as large will require only twice as much water.

Now we shall give the solution of this problem in detail.

When grains of rock or sand are allowed to drop vertically through still water, a maximum velocity is quickly attained, after which they fall with a uniform velocity through the water. If the grains are large, the velocity is greater than if they are small. Grains having a high specific gravity fall faster than grains having a low specific gravity. About 40 years ago a German mining engineer, Rittinger, made some experiments upon grains of different sizes up to about 0.4 in. in diameter, and deduced the following formula from his experiments:

$$v = 15.4 \sqrt{d(G-1)}$$

v = velocity of the grain, in inches, per second.

d = diameter of the grain, in inches.

G = specific gravity of the grain.

This formula relates to "average grains" and gives their velocity when falling through still water after they have attained a constant velocity. Rounded grains have a velocity about 10 per cent greater, and flat grains have a velocity about 20 per cent less than "average grains."

In 1894, Trans. Am. Inst. Min. Eng., Vol. 24, p. 409, Prof. Robert H. Richards made public the results of a large number of experiments on grains falling through water. The grains were all very small, none being larger than 0.08 in. They were allowed to fall through 8 ft. of water. Richards found that for quartz grains the velocity was:

$$v = 30 \sqrt{d}$$

According to Rittinger, with quartz having a specific gravity of 2.64, the velocity would be:

$$v = 20 \sqrt{d}$$

Since civil engineers and contractors rarely have to excavate rock much heavier than quartz, it will be safe to use Richard's formula—

$$v = 30 \sqrt{d}$$

In order to lift grains of rock vertically by means of an upward rising current of water, the velocity of the water must exceed the velocity that those grains would attain when falling through still water.

This is clearly the fundamental principle to be used in calculating the quantity of water required to keep a drill hole free of sludge by means of a water jet. Let A be the area in square inches of the drill hole at its mouth, then:

$$(1)\quad A = \frac{\pi D^2}{4}.$$

D being the diameter of the hole in inches.

Let Q be the number of gallons of water per minute rising through the drill hole, as delivered by the water jet, then:

$$(2)\quad Q = 60 \times \frac{vA}{231}.$$

v being the velocity of the rising current of water in inches per second. There are 231 cu. ins. per gallon, hence the 231 in the denominator. The 60 in the numerator is introduced to reduce a velocity (v) of inches per second to inches per minute.

Substituting for A its value given in equation (1), we have:

$$(3)\quad Q = \frac{60v}{231} \times \frac{\pi D^2}{4}.$$

Now, according to Richard's formula for the velocity of grains falling through still water, we have:

$$(4)\quad v = 30 \sqrt{d}$$

If the v in equation (3) is equal to the v in equation (4), we shall have barely enough water rising through the drill hole to elevate grains of sludge having a diameter d. Hence combining equations (3) and (4), we have:

$$(5)\quad Q = \frac{60 \times 30 \sqrt{d}}{231} \times \frac{\pi D^2}{4}$$

Substituting for π its value 3.14, we have:

$$(6)\quad Q = 6.1\ D^2 \sqrt{d}$$

In order to provide a small factor of safety that will insure the delivery of the grains of sludge at the mouth of the drill hole, let us substitute 7 for the 6.1 in equation (6). Then we have:

$$(7)\quad Q = 7\ D^2 \sqrt{d}$$

Q = gallons of water per minute

D = diameter of mouth of drill hole in inches.

d = diameter of largest grain of sludge in inches.

Formula (7) is the formula upon which the rule, above given, is based, and is not only perfectly reliable, but, we believe, a rational solution of a problem that has never been solved before.

In very tough rock the grains of sludge are often exceedingly small. Assuming that the largest grains to be elevated by the water jet are one-hundredth of an inch in diameter and that the hole is 2½ ins. diameter, and applying equation (7), we have:

$$Q = 7 \times (2\tfrac{1}{2})^2 \sqrt{\tfrac{1}{100}} = 4.375 \text{ gals per min}$$

This is practically 4½ gals. per minute.

In very soft rocks, like shale, the grains of sludge are often exceedingly large; and, as we have seen in applying the rule above, it will take 22 gals. per minute to elevate rock chips ¼ in. diameter through a drill hole 2½ ins. diameter at its mouth.

Should the specific gravity of the rock be greater than 2.6, our formula (eq. 7) must be modified in accordance with Rittinger's formula for grains falling in water, above given.

Now that an accurate method of fore-casting the amount of water for removing sludge and rock chips is available, there should be a much more frequent use of the water jet in the future than there ever has been in the past. There is nothing complex about the use of a jet. A small pipe, say, 3 ft. long, fastened to the end of the hose that supplies the water, is shoved down into the drill hole alongside the drill shank, and its nozzle is kept about 8 or 10 ins. above the bottom of the hole—the current of water does the rest.

By drying the sludge and screening it, the diameter of the largest grains to be lifted by the current of water is readily ascertained. It will be found, however, that upon the introduction of a water jet grains of larger size than were previously found in the sludge will be removed. This, in itself, is one of the strongest reasons why the water jet increases the efficiency of a drill for the drill bit is relieved of the work of pulverizing every chip of rock that it loosens. It is nothing remarkable to increase the number of feet of hole per day per drill by 50 per cent upon the introduction of a water jet of proper volume.

The Cost of Earth Excavation with Wagons During Winter Weather.

A factor that enters into the cost of earth excavation is the weather conditions under which the work is done. Excessively warm or cold weather means that both men and animals will do less work and cold, wet weather means that the roads for transporting the excavated material will be cut up, adding to the cost of hauling. In fact nearly every item of cost will be increased by bad weather.

In the job about to be described this was the case. The work was done in constructing a railroad in the month of February, when frequent snows and rain occurred, and for a number of days, the ground was freezing throughout the day. The work was started near a large body of water and a cold wind blew from over this water chilling the men and animals.

The ground was a sandy loam, and little or no loosening of the material would have been necessary if the weather had not been so cold. The material was taken from a large burrow pit and a few days' work with a plow would have loosened the 1,293 cu. yds. excavated; but, owing to the ground freezing, the plow had to be used 7 days. This alone added 4 or 5 cts. per cubic yard to the cost.

The earth was hauled in wagons an average distance of 2,500 ft. The dump was over a marsh, and an extra man was needed on the embankment to help cast the earth ahead, so the horses could walk over the marsh. The dumpmen also had to knock some of the earth out of the wagons on account of its being frozen. For two days a third man was needed to assist in this work. This added to the cost of dumping. The wagons used were 1½ cu. yd. capacity, National patent dump wagons, and they carried for each load about 1 cu. yd. place measurement. Ten round trips were made a day so each wagon took 10 yards to the dump and the lost time and time consumed in making the trip, averaged one hour for each load. This shows how the cost of hauling was increased as the teams should have traveled from 17 to 20 miles per day, instead of 10 miles.

The men shoveled 6.4 cu. yds. per day. With this kind of material from 12 to 14 cu. yds. per man-day should have been loaded, showing conclusively how the weather affected the physical exertions of the men. This small output of the men, increased the supervision cost per cubic yard.

The wages paid on the job for a 10 hr. day were as follows:

Foreman	$2.50
Laborers	1.50
Teams, driver and 2 horses	4.50
Plow, 2 men and 4 horses	9.00

The total cost of excavating and transporting the 1,293 cu. yds. 2,500 ft was:

Foreman	$ 44.00
Laborers	301.50
Teams	562.50
Plowing	63.00
Dumpmen	54.00
Total	$1,023.50

This gives a cost per cubic yard for the various items as follows:

Foreman	$0.032
Loosening	0.050
Loading	0.233
Dumping	0.041
Hauling	0.435
Total	$0.791

To illustrate how the weather did affect the cost of this work, a comparison of this unit cost with some work done on the same job during the previous autumn will be made. The weather conditions were ideal. The same wages were paid. The cost per cubic yard for the 2,500 ft. haul was:

Foreman	$0.016
Loosening	0.000
Loading	0.125
Dumping	0.019
Hauling	0.260
Total	$0.420

No plowing was done as the sandy loam was readily shoveled by the men without any loosening. The men shoveled 12 cu. yds. per day, and the teams carried 1 cu. yd., place measurement, for a load. This means that they traveled 17 miles per day. Two men were used on the dump, as during February.

Of the practically 600,000 miles of railway in the world but about 10 per cent are found in strictly tropical territory.

A Contractor's Bucket or Pail for Handling Heavy Materials.

The ordinary pail is not strong enough to stand the rough usage to which it has to be put on contract work. A wooden bucket soon falls to pieces, while a metal pail becomes battered and dented out of shape. Buckets used on construction work are used to carry heavy loads, such as concrete, asphalt, mud, mortar, tar and numerous other materials. To get the contents out of a bucket often necessitates pounding it on its staves or bottom. It is this work that quickly destroys most buckets.

We illustrate a bucket that is designed especially for contract purposes. The bucket is made of oak, heavily ironed. It has a reinforced bottom which makes it difficult to knock it out, even when used for soaking horses' feet, and the horse stands in the pail. A heavy iron strap passes down the sides of the bucket and across the bottom and is riveted on the top of the bucket in such a way that it is impossible to get it off without tearing the bucket apart. The bail is attached to the ends of this strap, which takes the strain and weight off of the staves. This is an important feature of the construction of a bucket, that is to handle heavy materials, especially in hoisting.

This bucket is also made with a counter sink hook on the inner top edge, which allows the pail being pounded on edge to remove its contents without injury to the staves. It is stated that this contractor's bucket will outlast a dozen of the ordinary kind. The price of this bucket is $8 per dozen, and at this price it is claimed that a contractor saves fully 50 per cent over using other buckets.

This contractor's bucket is manufactured by James S. Barron & Co., Franklin St. and West Broadway, New York. This company also makes all kinds of special tubs and wooden hoisting buckets, according to specifications furnished on special orders.

The greatest length of railway lines in any tropical country is in India (including Burma), which has 30,000 miles of line.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

The Detailed Cost of a Season's Work Laying Asphalt Pavements, Labor and Materials Itemized Separately.

BY F. E. PUFFER.*

The following is an account of the cost of laying 77,208 sq. yds. of asphalt pavement in an eastern city, which was a season's work.

The price paid for common labor was $1.50 a day, and $5 a day for team and driver.

COST OF ASPHALT PAVEMENT.
(77,208 SQ. YDS.)

	Per sq. yd.	Total Per sq. yd.
Grading street:		
Sundries	$0.021	
Labor	0.204	
Teams ($5 a day)	0.087	$0.312
Concrete base (6-in.):		
0.173 bbl. natural cement at $0.83	$0.144	
0.055 cu. yds. sand delivered at $0.98	0.054	
0.176 cu. yds. stone delivered at $1.62	0.285	
Sundries	0.015	
Labor laying	0.094	
Labor, general	0.001	$0.593
Binder (1½ ins.):		
Materials	$0.188	
Fuel	0.016	
Tools and sundries	0.001	
Labor, yard	0.026	
Labor, laying	0.023	
Labor, general	0.001	
Teams, hauling ($5 a day)	0.024	$0.279
Surface (2-in.):		
Materials	$0.645	
Fuel	0.022	
Tools and sundries	0.054	
Labor, yard	0.053	
Labor, laying	0.047	
Labor, general	0.028	
Teams, hauling	0.035	$0.884
General Expense:		
Salaries	$0.018	
Rent and expenses	0.014	
Plant, etc.	0.025	$0.057
Grand total		$2.125

The exact proportions of the materials used in the binder and in the surface coats are not available, but the prices paid for materials and supplies were as follows:

Binder stone	$1.00 per cu. yd.
Asphalt	$50.75 per ton
Petroleum residuum	7⅞ cts. per gal.
Sand	65 cts. per cu. yd.
Pulverized lime stone	$3.50 per ton
Coal (anthracite) used in dryers	$3 per ton
Coal (soft) used under boilers	$2.85 per ton
Wood to heat asphalt tanks	$4 per cord

It will be noted that the cost of the asphalt was much higher than it is at present, the present price being about $30 a ton. Since there are about 4 lbs. of asphalt per sq. yd. of binder, and about 19 lbs. per sq. yd. of surface coat, the difference of $20 a ton (or 1 ct. per lb. of asphalt) would reduce the above given costs by 4 cts per sq. yd. of binder and 19 cts. per sq. yd. of surface coat.

An old plant having a value of about $22,000 was used. The plant repairs amounted to $1,525, or 2 cts. per sq. yd., which is unusually low. Ordinary plant charges are about 7½ cts. per sq. yd. where a modern plant is used, but in such cases the labor cost is lower than in this case. I have made no allowance for interest on and depreciation of plant.

The fallacy of attempting to estimate the cost of asphalt pavements from a single day's operation is clearly shown by comparing the records of costs on different jobs extending over considerable periods of time. Marked differences of cost occur, arising partly from variations in local conditions, and partly from the varying efficiency of the workers, and partly from the exactions of the inspector.

The following are the costs of three different streets, showing how costs vary.

Contract A was performed under favorable weather conditions on a suburban street, close to the source of supply of concrete materials and far from the paving plant. The cost was a little below the season's average above given:

CONTRACT A.
(3,284 SQ. YDS.)

	Per sq. yd.	Total Per sq. yd.
Grading street:		
Sundries	$0.019	
Labor	0.123	
Teams	0.089	$0.231
Concrete base (6-in.):		
Natural cement at $0.866 per bbl.	$0.138	
Sand at $0.92 per cu. yd.	$0.051	
Stone at $1.77 per cu. yd.	0.295	
Sundries	0.015	
Labor	0.093	$0.592
Binder (1½-in.):		
Materials	$0.192	
Fuel	0.011	
Tools and sundries	0.002	
Labor, yard	0.024	
Labor, laying	0.024	
Teams hauling	0.024	$0.277
Surface (2-in.):		
Materials	$0.673	
Fuel	0.026	
Tools and sundries	0.055	
Labor, yard	0.047	
Labor, laying	0.042	
Labor, general	0.029	
Teams hauling	0.035	$0.907
General expense	$0.042	$0.042
Grand total		$2.049

Contract B was the last contract of the season. Weather was unfavorable but not severe. Length of haul was less than the average for the season. The forces, except asphalt, were somewhat demoralized by the fact that the job would soon end. The cost was naturally high:

CONTRACT B.
(5,278 SQ. YDS.)

	Per sq. yd.	Total Per sq. yd.
Grading street:		
Sundries	$0.021	
Labor	0.138	
Teams	0.129	$0.288
Concrete base (6-in.):		
Cement at $0.845 per bbl.	$0.142	
Sand at $1.18 per cu. yd.	0.063	
Stone at $1.93 per cu. yd.	0.321	
Tools and sundries	0.015	
Labor	0.104	$0.645
Binder (1½-in.):		
Materials	$0.195	
Fuel	0.011	
Labor, yard	0.030	
Labor, laying	0.025	
Teams hauling	0.025	$0.287
Surface (2-in.):		
Material	$0.666	
Fuel	0.023	
Tools and sundries	0.056	
Labord, yard	0.041	
Labor, laying	0.053	
Labor, general	0.029	
Teams hauling	0.035	$0.903
General expense	$0.057	$0.57
Grand total		$2.180

Contract C varies from the others in having a 1-in. binder and a 1½-in. surface specified. As a matter of fact, however, the asphalt was laid thicker than specified, due to the fact that the men had not been used to laying any light pavement that year. The work was located near the paving plant, also near the source of supply of cement, etc. The weather was good. The cost was naturally low:

---

*52 North 11th St., Newark, N. J.

CONTRACT C.
(2,404 SQ. YDS.)

	Per sq. yd.	Total Per sq. yd.
Grading street:		
Sundries	$0.021	
Labor	0.110	
Teams	0.091	$0.222
Concrete base (6-in.):		
Cement at $0.876 per bbl.	$0.151	
Sand at $0.71 per cu. yd.	0.039	
Stone	0.205	
Tools and sundries	0.016	
Labor	0.069	$0.480
Binder (1-in.):		
Materials	$0.152	
Fuel	0.009	
Sundries	0.001	
Labor, yard	0.027	
Labor, laying	0.020	
Teams hauling	0.005	$0.215
Surface (1½-in.):		
Materials	$0.405	
Fuel	0.019	
Tools and sundries	0.042	
Labor, yard	0.043	
Labor, laying	0.062	
Labor, general	0.022	
Teams hauling	0.007	$0.690
General expense	$0.057	$0.057
Grand total		$1.664

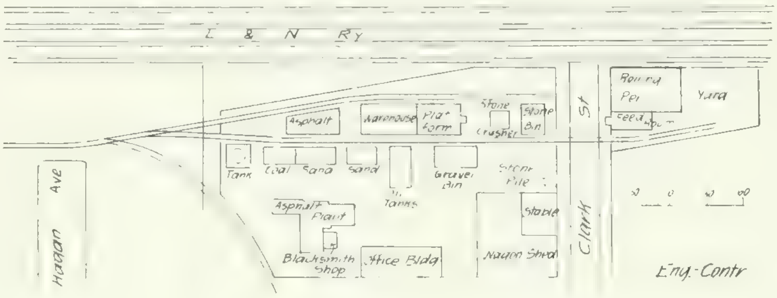
It seems to the writer that while the ordinary cost estimates based on a single day's work are valuable, and often the best that can be obtained and set a standard which superintendents should strain every nerve to maintain, nevertheless the above figures show that there is an elusive something governing the cost of work which daily cost estimates fail to indicate. This may be supplied in part by the trade instinct of an experienced estimator and partly by reference to tables of averages of similar work. In any event, however, differences between estimates and results, if they do not balance each other, will make or break any contractor.

What is claimed to be the most powerful engine ever built has recently been completed by the Allis-Chalmers Co. for the U. S. Steel Corporation. The engine, which has a capacity of 25,000 H. P., weighs 550 tons, without foundation-plates or fly-wheel. It is a horizontal, twin-tandem rolling mill engine, with cylinders 42-in. and 70-in. by 54-in. stroke, designed to operate condensing at 175 lbs. steam pressure and a speed of 150 to 200 R. P. M., developing its maximum power at the highest number of revolutions.

The Municipal Asphalt Repair Plant of New Orleans—Its Cost and Data on Its Operation.

The contract for the first asphalt pavement in New Orleans was let on Oct. 13, 1883, and the work was completed on Dec. 31, 1884. The contract embraced 49,830 sq. yds. of pavement, consisting of a 6-in. concrete foundation with ½-in. binder cushion and 2-in. wearing surface; the contract price was $3.50 per square yard. This and the pavements covered by the three succeeding contracts were laid under a 20-year maintenance guarantee. The remainder of the pavements, including part of those constructed in 1887, were laid under a 5-year maintenance guarantee. The total amount of asphalt pavement, maintenance of which by its constructors had expired prior to Jan. 1, 1908, was 549,749 sq. yds. Of this amount 398,536 sq. yds. is to be maintained by the city, and 151,213 sq. yds. by the New Orleans Ry. & Light Co.

Previous to December, 1904, no serious and definite effort had been made to provide for the systematic care of the asphalt pavements on which the maintenance contracts had expired, although during 1903 $69,597 was expended in repairs. No repairs whatever were made during 1904, and in the next 18 months but $43,450 was expended for repairs. As a result nearly all of the asphalt pavement under the direct care of the city was badly in need of repairs. In order to care for this pavement the city decided to erect a plant and accordingly in 1904 asked bids for furnishing and erecting a repair plant. The specifications under which bids were asked gave the fullest latitude to bidders in designing the arrangement of the plant and in selecting the machinery, apparatus, fixtures, etc. It was required, however, that the plant be operated with coal as a fuel, and that it be capable of turning out each 10-hour working day not less than 1,000 sq. yds. of binder when laid 1½ ins. thick after compression on the street or 1,000 sq. yds. of pitch asphalt wearing surface when laid 2 ins. thick after compression. The Warren Bros. Asphalt Paving Co., of Cambridge, Mass., was the only bidder and on Dec. 5, 1905, its bid was accepted. The plant was accepted by the city on Aug. 21, 1906. A report on the operation of the plant for the year ending Aug. 31, 1907, has just been made by Mr. W. J. Hardee, City Engineer, and from this report has been taken the matter in this article.



Sketch Showing Layout of New Orleans Asphalt Repair Plant.

PLANT, STRUCTURES AND EQUIPMENT.

The plant was erected in a lot of ground 175 ft. x 260 ft., owned by the city and formerly employed for garbage disposal purposes. The plant furnished and erected by the Warren Bros. Asphalt Paving Co. covers about 1,500 sq. ft. of ground and consists of a building formed of concrete foundation, brick walls and floors and roof of steel beams, expanded metal and cinder concrete. The boiler and engine section is 1 story high; the dryer section and the asphalt melting tanks section are each 2 stories high, and the central or tower section, containing the sand bin, the mineral dust bin, and the mixer, is 3 stories, or 32 ft. high. The boiler and engine, the dryer, and the asphalt melting tanks each have a substantial foundation of concrete, independent of the foundation of the buildings. The hot sand, or stone bin, and the mixer, together with their auxiliary apparatus, are carried on a conical-shaped steel frame, 4-legged tower erected just within the building and resting on pier concrete foundations independent of building foundations.

The cost of the plant and the appurtenant structures was as follows:

Demolition of old garbage plant buildings	$475
Asphalt plant—Warren Bros. Asphalt Paving Co.'s contract, $16,862.50; city alterations and additions, $2,736.50	19.599
Yard fences and gates	859
Switch tracks	1,189
Yard pavements and drains	6,721
Tower tank and filter	1.330
Water pipes and outlets	1,015
Warehouse and platform	1.471
Asphalt shed	289
Blacksmith shop and equipment	222
Stable, rolling pen and wagon shed	5.311
Stone crusher and storage bin	1,966
Yard material bins	332
Office and store room building	5.509
Landing bins and roads	1.432
Lighting	352
General cleaning of premises	298
Total	$48,365

While the building of the municipal repair plant was in progress and nearing completion the following equipment was provided:

The live stock consist of 17 mules and 3 horses; the mules are used in wagons and carts and the horses in buggies. The harness consists of 6 sets of double wagon harness, 10 sets of single cart harness and 2 sets of single buggy harness. The stable equipment consists of hose for washing live stock and rolling stock, curry combs, brushes, halters, blankets, and other articles usually used in well conducted stables.

The rolling stock consists of 10 Watson, 4-wheel, 2-cu.-yd. asphalt dump wagons; 8 1-cu-yd., single-mule dump carts; 2 Tennessee 4-wheel wagons with capacity of 4,000 lbs. each; 1 4-wheel float dray, 5 inch-tires, with capacity of 6 tons; and 1 4-wheel, single-horse storm buggy. Each wagon and cart is equipped with a canvas (tarpaulin) cover.

In addition to 134 tools of various kinds necessary to operate the plant furnished by the Warren Bros. Asphalt Paving Co., the plant is equipped with the following: 1 Fairbanks platform scales mounted on rollers for weighing materials; 1 4-wheel 3-ft 10-in. by 2-ft. 10-in. Fairbanks wagon hand truck; 12 iron frame and bed wheelbarrows; 6 short-handle shovels; 12 long-handle shovels; 10 axes; 6 picks; 8 crowbars; 8 sledgehammers, assorted sizes; and a number of small tools of various kinds.

The street tools consist of the following: 2 large-size tool boxes, made by city; 18 wooden street barriers, made by city; 1 Universal 8-ton steam asphalt roller; 1 Universal 3½-ton steam asphalt roller; 1 1,000-lb. iron hand asphalt roller; 1 4-wheel fire wagon for heating, tamping and smoothing irons; 1 2-wheel, 100-gal. mixing kettle; 18 asphalt tamping irons; 15 asphalt smoothing irons; 66 asphalt axes; 107 picks; 18 mattocks; 102 long-handle shovels; 40 short-handle shovels; 24 iron frame and bed wheelbarrows; 6 axes; 200 lin. ft. of 1-in.-diameter wire wrapped rubber hose; 6 sledgehammers; 8 chisels of various sizes; 10 crowbars; and a number of small tools of various kinds.

The testing laboratory, operated in connection with the plant, is equipped with cement testing apparatus, oil tester, brick tester, etc.

The cost of this equipment may be summarized as follows:

Live stock, harness, and stable equipment	$6,107
Rolling stock and equipment	3,180
Plant tools	837
Street tools	5,492
Office furniture	447
Laboratory equipment	1,490
Total	$17,644

Soon after the plant was placed in operation the city ordered it to do a considerable amount of work not originally contemplated. This included the repairing of streets other than those paved with asphalt, and accordingly the following additional equipment was purchased:

Pioneer, 7-ton steam road roller	$1,113
Champion steel road grading machine	150
Austin, 700-gallon capacity road sprinkler	396
Rolling stock	1,027
Railroad plows with extra points	39
Wheel scrapers	140
Harness	139
Live stock	1,700
Total	$4,704

The road roller was purchased second-hand for $500 and was overhauled and repaired at a cost of $613. The wheel scrapers and road girder were also purchased second-hand, for a little more than half their original cost. For the plow and grading machine mules 17½ hands high and weighing about 1,600 lbs. were secured.

Summarizing, the total cost of the plant and equipment is seen to be as follows:

Structures and their equipment	$48,365
Equipment	17,673
Additional equipment	4,704
Total cost	$70,583

SUPPLIES.

Certain of the supplies used in connection with the plant were purchased by contract. These included the following:

Lake Shore sand at 90 cts. per cu. yd. in barge load lots on board barges moored at repair plant landing; Tchefuncta River sand at $1.50 per cu. yd., conditions of delivery the same as for Lake Shore sand; washed river gravel at $2.27 per cu. yd., in carload lots on board cars at repair plant switch track; Brilliant Nut (screened) coal, at $2.75 per ton, in carload lots on board cars at repair plant switch track; refined asphalt at $18.50 per net ton f. o. b. yard of repair plant. All other supplies were purchased from time to time, as they were required, in open market, in carload lots or less.

In the following table are shown the amount and value of the materials and supplies used in connection with the plant between Sept. 1, 1906, and Aug. 31, 1907:

	Av. Unit Cost.	Total.
Asphalt, 465.99 tons	18.50	$8,561
Fluxing oil, 125,527 lbs	.0075	940
Naphtha, 6,753 gals	.15	1,019
Lake Shore sand, 2,580 cu. yds.	.99	2,566
River sand, 1,779 cu. yds	1.64	2,920
Tchefuncta River sand, 250 cu. yds.	1.60	400
Mineral dust, 321 tons	5.50	1,764
River gravel, 564 cu. yds	2.27	1,272
Cement, 1,936 bbls	2.04	3,944
Coal, 389 tons	2.84	1,105
Clay gravel, 3,178 cu. yds	1.50	4,786
New small granite blocks, 3,240	.07	227
Old small granite blocks, 4,600	.04	184
New building brick, 9,000	....	98
Old building brick, 8,500	....	25
Pine wood, 49¾ cords	5.68	283
Oak wood, 41½ cords	6.74	280
Lake shells, 3,618 cu. yds	1.46	5,304
Brickbats, 696 cu. yds	1.48	1,032
Cast iron, 32,924 lbs	....	1,289
Drain pipes and Y's, 3,026 lin. ft.	....	979
Laboratory supplies	....	24
Office supplies, stamps, etc	....	436
Engineers' supplies	....	606
Oats, 122,172 lbs	.015	1,820
Bran, 6,600 lbs	.01	66
Hay, 39¾ tons	24.72	983
Stable supplies	....	309
Blacksmith supplies	....	87

LABOR.

The following is a list of the permanent employes:

	Annual Wage.
Superintendent	$2,500
Secretary	1,800
Stenographer	720
Street foreman	1,500
Assistant street foreman	1,200
Yard foreman	1,500
Engineer	1,500
Fireman	780
Steam roller engineer	1,380
Blacksmith	1,080
Yard clerk	720
Messenger	600
Hostler	720
Night watchman	720
Veterinary	180
Chemist	1,800
Chemist helper	720

From time to time such laborers, additional assistant foremen and other employes, as were required, were hired by the day. When operations were first commenced nearly all the plant and street employes were negroes, but as fast as white men who could satisfactorily do the work were found, the negroes were displaced; within a few months six negroes only remained and these were engaged at the plant on a class of work for which white men were not well fitted.

Teamsters and some of the laborers were paid at the rate of $1.75 per day; but the large majority were paid at the rate of $2 per 10-hour day. Pavers, stone workers and brick masons were paid from $2.50 to $4 per 8-hour day.

DATA ON OPERATION.

Each work executed by the repair plant was charged with the actual cost of materials and labor employed, but as there were fixed charges properly chargeable to all work, these charges were subdivided into two heads, special charges and general charges, and proportionately charged to each work on the basis of cost of material and labor actually employed.

The following is a statement of the items and amounts included in special charges which have been proportionately apportioned to the cost of repair of asphalt pavements and the cost of new asphalt pavements:

One-half chemist's salary for year..	$720
One-half chemist's helper's salary for year	310
One-half cost of laboratory supplies.	12
One-half cost of gas	4
Engineer's salary for year	1,450
Fireman's salary for year	725
Engineer's supplies	606
Coal used at plant	972
Pine wood used at plant	30
Oak wood used at plant	46
One-half day laborer's wages at plant for year	8,092
Damaged cement	100
Total	$13,066

The testing laboratory also serves the City Engineer's Department, hence the division of cost.

General charges included all expenditures for the year, other than those included in special charges, and for materials and labor employed in repairing asphalt pavements, constructing new asphalt pavements and executing miscellaneous improvements. The following is a statement of the items and amounts:

Annual employes' salaries	$15,673.96
One-half day laborer's wages at plant	8,002.35
Live stock fed	3,032.76
Electric lighting	331.75
Electricity for crusher	133.35
Water at plant	300.00
Water on street	163.50
Blacksmith's supplies	87.52
Office supplies	436.00
Stable supplies	309.30
Horseshoeing	404.70
Extra teams	1,629.10
Car fare and incidental expenses.	570.90
Lost and worn-out tools	265.80
Lost live stock	270.00
Total	$31,790.99

The plant was placed in operation in August, 1906, and from Sept. 1, 1906, to Aug. 31, 1907, cared for 352,302 sq. yds. of asphalt pavement, on which maintenance guarantees had expired. The gross cost of this work was $40,307 or 11.44 cts. per sq. yd. on all of the asphalt pavement under the direct care of the city. The repair work consisted of the construction of 8,024 cu. ft. of concrete, 23,682 sq. yds. of naphtha coat and 35,905 sq. yds. of asphalt wearing surface, the cost being as follows:

Materials	$15,279
Labor	7,177
Proportion of special charges	6,761
Proportion of general charges	11,090
Total	$40,307

During the year the repair plant forces constructed new asphalt pavements on portions of eight streets, at a gross cost of $37,589. This work included 6,125 sq. yds. of grading, 36,707 cu. ft. of concrete, 8,369 sq. yds. of naphtha coat and 8,396 sq. yds. of wearing surface. The cost of the work was as follows:

Materials	$12,130
Labor	8,812
Proportion of special charges	6,305
Proportion of general charges	10,342
Total	$37,589

In addition to the work on asphalt pavement a considerable amount of miscellaneous improvements were made, including curb setting, repairing with crushed stone, grading, billing, and the like. The total cost of these miscellaneous improvements was $31,347, made up as follows:

Materials	$13,854
Labor	7,129
Proportion of general charges	10,364
Total	$31,347

Practically all of the crushed stone used in the concrete foundation for the new asphalt pavements was obtained from the rock crusher operated in connection with the repair plant. The plant turned out 1,143 cu. yds. of crushed stone and old vitrified paving brick at a cost, for power and direct labor, of $533 or 46.66 cts. per cu. yd. The stone was secured without cost. The crusher is a Reliance crusher equipped with 4 sets of toggels for the crushing of stone into six different sizes. It is driven by a Westinghouse 20 H. P. induction motor; the motor is housed in a very small but substantial frame building to protect it against dust and the weather; it is erected on a concrete foundation and surrounded by a cement mortar finished floor. The motor also drives the endless chain bucket elevator, which lifts the crushed stone 24 ft. into the storage bin. This motor also drives some of the blacksmith's apparatus as well as the chemist "rattler" for testing paving brick and stone. Around the receiving hopper of the crusher is a platform 21 ft. by 14 ft. and 6 ft. above the yard surface for the convenient handling of material to be crushed.

Including feed, hostler's and stable boy's wages, veterinary's salary, shoeing, medicines, etc., it cost an average of 64.9 cts. per head per day to feed and care for the live stock.

The repair plant forces worked every day throughout the entire year, except Sundays, non-working holidays and days when it rained. The asphalt plant worked 141 days and turned out altogether 88,947 cu. ft. of "wearing surface" mixture, equivalent to 49,415 sq. yds. of pavement 2 ins. in thickness; the largest day's run was 1,845 cu. ft. and the smallest day's run was 45 cu. ft.

When the plant was operating, one man only, at $3.00 per night, was engaged, at the plant, at night. The melting tanks were loaded during the day and this man fired the main boiler, operated the air compressor, and attended to proper temperature being maintained, by means of the steam heating coils, in the tanks; when the plant was not operating, this man worked in the yard, as a skilled laborer, at $2.50 per day. On an average 6 hours were consumed in converting one tank of asphalt and fluxing oil into suitable asphaltic cement.

In all instances naphtha coat, in lieu of so-called binder, was employed in both repaving old pavements and constructing new pavements. Naphtha binder was not only much cheaper but Mr. Hardee considers it also much more substantial and durable. This coat is described in the report as follows. Naphtha coat is formed of vaporized gasoline and asphalt mixed in equal proportions; it is put on the concrete foundation, when the same is perfectly dry, by hand, with brushes, just as paint would be applied, and to the least possible thickness; it is practically impervious to moisture and prevents the moisture that is commonly ever present in the concrete foundation of our pavements from attacking, through capillary attraction, the base of the asphalt "wearing surface" and rotting it; additionally, the "naphtha coat" effects a strong union of the concrete foundation and the asphalt "wearing surface" and prevents the latter from being displaced in warm weather, as is so frequently the case in old pavements in which gravel "binder" has been employed. In repairing old pavements where the combined thickness of the "binder" and "wearing surface" was considerably more than 2 ins. concrete was generally added to the original concrete foundation.

The cost of the raw materials—that is, asphalt, fluxing oil, sand, mineral dust and naphtha—necessary to construct 1 sq. yd. of asphalt wearing surface with naphtha coat, on the basis of 16 2-3 per cent shrinkage in compressing by steam roller, was 39.13 cts.

The largest day's run made by the asphalt plant was on June 24, 1907, when surfacing (new pavement) the Esplanade-Claiborne Ave. intersection. In 9 hours, 205 boxes, gross, of "wearing surface" mixture were turned out; 3 Watson wagons hauled this material from the plant to where it was laid, a distance of a little more than 2 miles; and this material completed 1,020 sq. yds. of pavement intended to be 2 ins. in thickness. The cost of the fuel and labor, including wages of plant foreman, employed in preparing the "wearing surface" mixture; the wages of wagon drivers and the care and feed of the teams; and the labor, including foreman, roller men and fuel, in laying the "naphtha coat" and "wearing surface" amounted in all to $127.23, or 12.47 cts. per sq. yd. Preparing the sub-grade for the foregoing pavement cost 14 cts. per sq. yd.; the concrete foundation, 6 ins. in thickness, cost 87 cts. per sq. yd.; and the "naphtha coat" and asphalt "wearing surface" cost 51.6 cts. per sq. yd., making a total cost of $1.536 per sq. yd. for materials (on the basis of aggregate for concrete foundation having cost $2.27 per cu. yd.) and labor actually employed, and of $1.64 per sq. yd. including special and general charges.

One box, or 9 cu. ft., of asphalt "wearing surface" mixture will lay 5 sq. yds. of completed pavement 2 ins. in thickness. In the general case the new pavement laid in making repairs exceeded 2 ins. of thickness, because "binder" was not used, which accounts for the seeming discrepancy in the quantity of "wearing surface" mixture turned out by the plant and the number of square yards of pavement actually laid; because of greater thickness than 2 ins. the 44,301 sq. yds. of pavement actually laid was equal to 49,415 sq. yds. of pavement 2 ins. in thickness.

It is worthy of note that no allowance was made in the above costs for interest or depreciation on the plant.

Specifications of the National Cement Users' Association for Cement Sidewalks.

At the convention of the National Cement Users' Association held at Buffalo, N. Y., Jan. 21-23, the Committee on Sidewalks, Streets and Floors presented the following specifications for cement sidewalks:

The ground base should be made as solid and permanent as possible. Where excavations or fills are made, all wood or other materials which will decompose should be removed and replaced with earth or other filling like the rest of the foundation.

Fills of clay or other material which will settle after heavy rains or deep freezing should be tamped solid in layers not more than 6 ins. in thickness, so as to insure a solid embankment which will remain firm after the walk is laid.

Embankments should not be less than 2½ ft. wider than the walk which is to be built. When porous material, such as coal ashes, granulated slag or gravel, is used, under drains of agricultural tile should be laid to the curb drains or gutters so as to prevent water accumulating and freezing under the walk and breaking the blocks.

The position of shade trees should not be less than 4 ft. from the walk. Carolina poplar, elm or shade trees whose roots run near the surface of the ground should not be less than 10 ft. from the walk.

Lines and grades should be given by a civil engineer; the stakes to be not over 25 ft. apart and far enough from the walk line so that an inspector may see that the walk is laid to line grade.

The mold strips should be firmly blocked under the ends of the center of the strips and carefully straight-edged, care being taken that the strips are parallel with the engineer's line and the height of the grade stakes. The walks should be laid with a drop of ¼ in. to the foot toward the curb gutter.

The thickness of the walk should be determined by the location, the amount of travel and danger of being broken by heavy bodies falling on it, or frost.

Business front walks should not be less than 4 ins. thick and can be 6 ins. with profit. The top coat of business walks should not be less than 1¼ ins. thick.

In residence districts the top coat should not be less than 1 in. wearing thickness, and the thickness for different widths of walks should be as follows:

Six feet wide, the minimum at the centers should be 4½ ins. thick; at the edges, 4 ins. thick.

Five feet wide, the minimum at the centers should be 3¾ ins. thick; at the edges, 3½ ins. thick.

Four and one-half feet wide, the minimum at the centers should be 3¾ ins. thick; at the edges, 3½ ins. thick.

Four feet wide, the minimum at the centers should be 3½ ins. thick; at the edges, 3 ins. thick.

All other widths, the minimum at the centers should be 3½ ins. thick; at the edges, 3 ins. thick.

Size of blocks may be determined by the width and thickness of the walk. Business front walks should contain not over:

12 sq. ft. when the walk is 4 ins. thick.
16 sq. ft. when the walk is 5 ins. thick.
20 sq. ft. when the walk is 5½ ins. thick.
25 sq. ft. when the walk is 6 ins. thick.

Residence districts, where the walks are:

6 ft. wide, 5 ins. thick at the center, the blocks should be not over 6 ft. or less than 4 ft. long.

6 ft. wide, 4½ ins. thick at the center, the blocks should be not over 5 ft. or less than 4 ft. long.

5 ft. wide, 4½ ins. thick at the center, the blocks should be not over 5 ft. or less than 4 ft. long.

5 ft. wide, 4 ins. thick at the center, the blocks should be not over 5 ft. long, or less than 4 ft. long.

4½ ft. wide, 4 ins. thick at the center, the blocks should be not over 4½ ft. or less than 3 ft. long.

4 ft. wide, 4 ins. thick at the center, the blocks should be not over 4 ft. or less than 3 ft. long.

4 ft. wide, 3½ ins. thick at the center, the blocks should be not over 4 ft. or less than 3 ft. long.

Other widths less than the above 4 ins. thick at the center the blocks should be not over 4 ft. or less than 2½ ft. long.

Other widths less than the above 3½ ins. thick at the center the blocks should be not over 3½ ft. or less than 2½ ft. long.

Concrete.—Bottom coat gravel. The largest size to not be over 1 in. and all under ⅛ in. to be considered sand. Proportions to be one part high-grade Portland cement to four parts clean hard gravel, and sand enough to fill the voids, which makes the proportions, as most gravel will measure, after being filled with sand, 1 part cement to 5 of the whole aggregate sand and gravel.

Bottom coat crushed stone.—The size of broken stone should not be larger than ¾ in. and vary in size to ¼ in. and free from fine screenings and dust or soft stone. Proportions to be 1 part high grade Portland cement, 2 parts clean and sharp sand and 4 parts broken stone, or what is termed by consulting engineers and concrete experts as 1 cement to 4 of stone, and sand enough to fill the voids.

Mixing of both gravel and broken stone should be done by placing stone in the mixing box or on the platform first, then spread the sand evenly over the stone and in like manner the cement over the sand. Then cut through from top to bottom in thin slices, which will insure an even mix. Then turn with hoe or shovel twice before adding water, which should be done with a sprinkler and hoed over as sprinkled. The batch should be turned at least once after the water is applied. The amount of water used in the bottom coat should be only enough to make it, when firmly tamped, solid and not quaky.

Top coat.—Three parts high grade Portland cement and 5 parts clean, sharp sand mixed dry and screened through a No. 4 sieve. In the top coat the amount of water used should be just enough so that the surface of the walk can be tamped, struck off, floated and finished within twenty minutes after it is spread on the bottom coat, and when finished it should be solid and not quaky.

An edger not less than 1 in. radius should be used on the out edges of the walk.

Separation of the blocks should be done with a spud not over 6 ins. wide and ¼ in. thick, and to insure complete separation the groove should cut through into the ground base. Fill the groove with dry sand before the top coat is spread and the top coat should be cut through to the sand after floating and troweling and a jointer run in the groove, then again draw a trowel through the groove so as to insure a complete separation of the blocks.

The protection of newly finished walks from storms can be accomplished by covering with roofing paper or canvas. Canvas should never be laid on the walk, but stretched over on a slant so as to run the water off.

Grading after the walks are ready for use should be on the curb side of the walk 1½ ins. lower than the walk and not less than ¼ in. to the foot fall toward the curb or gutters. On the property side of the walk the ground should be graded back at least 2 ft. and not lower than the walk, which will insure the frost throwing the walk alike on both sides.

The ministry of communications of Russia has introduced in the Duma a bill to double-track the Siberian railroad, which, it is estimated, will cost nearly $80,000,000.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Labor Cost of Building a High Power Transmission Line.

A high power transmission line was to be run for about 20 miles. For all but 9,500 ft. of this distance poles were up and being used for other purposes. For the distance named an entirely new line had to be built. This part of the line was along a public road. The poles and cross arms were delivered at one end of the line by railroad, so the average haul on material was about one mile. The poles were from 30 to 33 ft. long, measuring from 5 to 9 ins. at the top and from 12 to 12 to 18 ins. at the butt.

The wages paid for a 10-hr. day on the work were as follows:

Foreman	$3.00
Laborers	1.50
Linemen	2.50
Team 2 horses and driver	4.50

Hauling.—The poles were hauled on a two-horse wagon, one man assisting the driver in loading and unloading them. Naturally a large per cent of the cost of hauling was in taking the poles from the cars and unloading them from the wagon. The poles were of chestnut, fairly light, and 8 to 10 poles could be hauled at a trip. The cost of hauling the poles was:

Team	$22.50
Laborers	7.50
Total	$30.00

Digging Holes.—In digging the holes for the poles, one man worked on a hole. He used a digging bar, a shovel with extra long handle and a spoon with same length handle. The holes were dug 5 ft. deep and were 30 ins. in diameter at the top and about 18 ins. at the bottom, making an average diameter of 2 ft. From each hole was excavated 0.58 cu. yd. The material was a red sandy clay, and the holes were all dry. There were 74 holes dug. The cost was:

Foreman	$17.25
Laborers	55.50
Total	$72.75

The cost per hole was as follows:

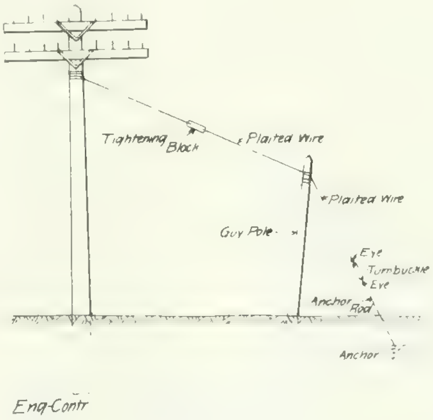
Foreman	$0.23
Men	0.75
Total	$0.98

The cost per cu. yd. was as follows:

Foreman	$0.40
Men	1.30
Total	$1.70

It will be noticed that one man dug 2 holes per day. In ENGINEERING-CONTRACTING, Jan. 1, 1908, page 8, a record of digging holes is given. Holes 5 ft. in diameter and 5 ft. deep were dug at the rate of two per man-day, at the same rate as these holes were dug. On these larger holes about 6 times as much earth was handled at the same cost, thus showing how much cheaper earth can be handled from a hole large enough to admit of a man working in it. The pole holes had to be dug by the man standing over the hole. Another item that affects the cost is that on the larger diameter holes, two men worked together, while on the pole holes only one man worked on a hole, which meant a slow pace.

Raising Poles.—The pole raising was done by hand. A deadman and a jenny were used, these being manipulated by two men. The foreman or a lineman held a metal slide in the hole for the butt of the pole to slide against, keeping it from gouging into the side of the hole. The rest of the crew used pikes to lift the top of the pole, and place it in the hole. The crew consisted of the foreman, one lineman and about 7 men.



Sketch Showing Method of Placing Guy Wires.

The method of operation was as follows: The pole was rolled to the hole by means of bars and cant hooks. The slide meantime was placed in the hole. Then the crew lifted the small end onto the jenny which held it until the deadman was put in place. With the pole resting on the deadman, the pikes were brought into play, and as the pole was lifted the deadman was moved up under the pole until the final lift came that sent the pole into the hole. Then it was turned and lined up, the lineman assisting the foreman in this work, after which the refilling of the hole was done.

A record of this work was kept in detail on a number of poles, from which it was found that the average time consumed in the work was as follows:

Getting ready to set pole, 3 minutes; raising pole, 6 minutes; lining pole, 2 minutes; filling and tamping earth in hole, 1 man shoveling and 3 tamping, 10 minutes, several men standing by the pikes to steady the pikes; moving to next hole, 4 minutes; total time, 25 minutes.

When everything is working well this average can be maintained, but a little time is occasionally lost due to unforeseen obstacles that prevent this speed. The cost of raising the poles was:

Foreman	$10.50
Laborers	37.50
Lineman	8.75
Total	$56.75

This, for the 74 poles, gives a cost per pole of the following:

Foreman	0.14
Laborers	0.50
Lineman	0.12
Total	$0.76

Cross Arms.—Before raising the poles, and while the laborers were digging the holes, the linemen were at work dapping the poles to receive the cross arms. The cross arms used were 8-pin arms, two being placed on each pole. At all times in the line, double cross arms were used, that is, a cross arm was put on each side of the poles. This was the case for nine poles. For future needs the poles were dapped in 3 places. This made 240 daps necessary. The poles, as stated, were chestnut. The cost of dapping the poles was $22.62, making a cost per dap of 9.8 cts.

One lineman placed the cross arms, the team hauling them along as needed, and the driver acting as the lineman's "ground hog." The sketch shows how these arms were placed, and braced with two pieces of galvanized iron. In all, 166 cross arms were used. The cost of this work was:

Hauling with team	$21.37
Lineman	6.25
Total	$27.62

The high cost of this was due to the fact that the team was charged to this work for the entire time of placing the cross arms, as it waited at each pole while the arms were being put in place. The cost per cross arm was 17 cts.

One lineman and a helper placed the insulators. The cost of this was:

Lineman	$3.75
Helper	2.25
Total	$6.00

Only six insulators were put on a cross arm, thus making 12 to a pole, except at the turns, as the line was to carry 12 wires. In all 996 insulators were used, hence the cost per unit was 0.6 cts.

Guy Poles.—In building lines with a number of wires on them, it is necessary to guy all poles where there are turns in the line, and on long straight lines some of the poles must also be guyed. The sketch shows the method used in guying this line, and is one frequently used. The guy pole holes were dug of about the same dimensions as the holes for the line poles. The cost was:

Foreman	$1.50
Laborers	6.75
Total	$8.25

The cost per hole was:

Foreman	$0.17
Laborers	0.75
Total	$0.92

The raising of the poles cost:

Foreman	$3.00
Laborers	9.00
Total	$12.00

This makes a cost per pole of $1.33. This is large, owing to the fact that the men lost considerable time moving from pole to pole and carrying their tools, also to the fact that each pole had to be cut and trimmed, as these guy poles were made from rejected line poles.

The method of placing the guy wires to the poles was as follows: The wire was fastened to each of the two poles, and then brought to the tightening block as shown in the sketch. With blocks and tackle fastened to the two poles, the poles were brought to a snug bearing and the wires were made fast around the tightening block, shown in the sketch. The wires go around the block in grooves made for the purpose at right angles to each other. While the linemen and their helpers are doing this work, the laborers are digging the anchor hole and placing the anchor rod. To this is fastened a turn buckle, and a wire is run from the guy pole to the turn buckle. The blocks and tackle are then fastened to a handy tree or stump, or if necessary to the anchor rod and the guy pole is pulled back, tightening the guy wire between the two poles, while the turn buckle is screwed up, thus making all the guy wires taut. At times, instead of making an anchor as shown, the anchor wire can be fastened to a convenient tree. Both kinds of anchors were used in this case. The cost of this work was:

Foreman	$1.50
Linemen	3.75
Laborers	3.75
Total	$9.00

This made a cost of $1.00 per pole, making a total cost per guy pole of $3.25.

About one-half of this line ran through the edge of woods or by shade trees. A few trees had to be cut down and a number trimmed; some tall bushes were also cut down. The foreman looked after this work part of one day when all his force was at work upon it, but for the most part linemen were in charge of several laborers doing this work. The cost of it was as follows:

Foreman	$2.25
Lineman	18.12
Men	13.13
Total	$33.50

Stringing the Wires.—As previously stated, 12 wires were strung on the poles. The wires were light weight. The team hauled the wire, and one horse was used in helping to string it, the other horse standing idle. In line work, a team is nearly always necessary, yet there are times that it may stand idle for hours, thus increasing the cost of that item to which it is charged. When there is nothing else for the wagon to do it is used to carry the tools along the line as the men work. In stringing the wire the horse pulled a rope fastened to two strands of wire at one time, thus running out two wires, and making six trips of the horse to string out the 12 wires. For this work 3 linemen were used, but in fastening the wires to the insulators only 2 linemen were used, and the wires were pulled tight by the helpers with blocks and tackle. The cost was:

Foreman	$18.00
Linemen	37.50
Laborers	27.00
Team	36.00
Total	$118.50

In all 21.6 miles of wire were strung and this made a cost of $5.50 per mile of wire.

Changing Poles.—At the ends of the line, where connections were made with the old line of poles, some poles had to be changed to make them suitable for the new service. There were 3 of these at one end and 1 at the other. The work consisted in taking down the old poles and putting in their place poles from 40 to 45 ft. long. Cross arms had to be put on the new poles, and the wires changed over to the new poles. It took a half day for the crew to do each pole, thus spending 2 days on the 4 poles. The cost of this was:

Foreman	$6.00
Lineman	2.50
Laborers	39.00
Team	9.00
Total	$56.50

This gave a cost per pole of $14.12. In line work the foreman is always a lineman, and in doing odd jobs this frequently keeps the cost down, as he will often do work that a lineman is called upon to do. As the lineman is the higher priced man he should be allowed to do only such work as the helper is not able to do.

Total Cost.—The total cost of the entire work was as follows:

Hauling	$30.00
Digging Holes	72.75
Raising Poles	56.75
Dapping Cross Arms	22.62
Placing Cross Arms and Insulators	33.62
Guy Poles	29.25
Trimming Trees and Bushes	33.50
Stringing and Fastening Wires	118.50
Changing Old Poles	56.50
Total	$453.49

There being 1.6 miles of line built, the cost per mile for each item was:

Hauling	$18.75
Digging Holes	45.47
Raising Poles	35.47
Dapping Cross Arms	14.14
Placing Cross Arms and Insulators	21.01
Guy Poles	18.28
Trimming Trees and Bushes	20.94
Stringing and Fastening Wires	74.06
Changing Old Poles	35.31
Total	$283.43

For the 74 new poles erected this makes a cost per pole for the completed line of $6.13. For cost of other work of this character see ENGINEERING-CONTRACTING, June 26, 1907.

* * *

Some experiments on the shrinkage of wood due to the loss of moisture recently completed by the Forest Service show that green wood does not shrink at all in drying until the amount of moisture in it has been reduced to about one-third of the dry weight of the wood. From this point on to the absolutely dry condition, the shrinkage in the area of cross-section of the wood is directly proportional to the amount of moisture removed. The shrinkage of wood in a direction parallel to the grain is very small; so small in comparison with the shrinkage at right angles to the grain, that in computing the total shrinkage in volume, the longitudinal shrinkage may be neglected entirely. The volumetric shrinkage varies with different woods, being about 25 per cent of the dry volume for the species of eucalyptus known as blue gum, and only about 7 per cent for red cedar. For hickory, the shrinkage is about 20 per cent of the dry volume, and for longleaf pine about 15 per cent. In the usual air dry condition, from 12 to 15 per cent of moisture still remain in the wood, so that the shrinkage from the green condition to the air dry conditions is only a trifle over half of that from the green to the absolutely dry state.

* * *

Signboards of blue enamel are to be placed by the State Highway Department of Pennsylvania on all state roads completed during the present year. The signs will be 18 in. long by 1 ft. wide and will contain the name of the road, the date and "State Highway," "Keep to the Right."

* * *

Here lie the remnants of Scaldy Bill
    Quinn:
Part of his pants and the tip of his chin;
All that we found of the powderman
    bright,
Wise to thawing of friz dynamite.

LETTERS TO THE EDITOR.

A Protest Against a Criticism of the High Labor Cost of Building a Reinforced Concrete Pipe by Day Labor.

Sir: In your issues of Sept. 11 and 18, 1907 you reprinted a paper on concrete pressure pipe. Being the author of that paper and the engineer in charge of the construction of the pipe, the writer was interested in your editorials of Sept. 18 and Nov. 6 on the subject, also in the letter of Chief Engineer A. P. Davis, appearing in the Nov. 6 issue.

Mr. Davis quotes several bids received recently by the Reclamation Service for concrete work, which bids you admit are unreasonably high. What do you think of the following bids which were received for the construction of the identical concrete pressure pipe, the "Pinto pipe"? Bids did not include trenching or backfilling; cement and reinforcement furnished by the government in Globe, Ariz., whence it would cost $1.50 per barrel to haul the cement to the work; lumber to be furnished by the government would cost contractor $15 per 1,000 ft. B. M. to haul.

Under these conditions five bids were received, viz.: $5.25, $7, $7.50, $15.50 and $16.50 per lin. ft. After paying for hauling the materials these prices would equal $4, $5.75, $6.25, $14.25 and $15.25 per lin. ft., or $9.30 to $35.45 per cu. yd. It may be said that the above bid of $7 per lin. ft. was from one of the most experienced and efficient contractors in the country.

The writer is not familiar with the considerations which determined the rejection of these bids; however, the following are some which became apparent as the work was being done.

This sort of pipe for this sort of service is perhaps not unique, but it was new to us, and considerable latitude as to methods was desirable. The movable form was an experiment deemed justifiable in order to obtain continuous work, and in view of the amount of similar future work proposed by the Reclamation Service. If built by contract the inspection would have been difficult and costly to secure an equal character of work. It was found necessary a number of times to divert cement entirely from this job in order to keep contractors on other parts of the work supplied, which could not have been done if this pipe had been built by contract. You have compared the labor cost per cubic yard on this pipe with that on other pipes, to the disadvantage of this one; I would like the privilege of analyzing some of your comparisons.

First, in reprinting the cost of the Pinto pipe in your issue of Sept. 18, 1907, you changed the form somewhat, and make it appear that the cost does not include the foreman at $175 per month and the sub-foreman at $3.50 per day. The cost of the foremen is included in the Pinto figures, and was distributed among the items into which the cost was divided.

You must admit that other things being equal the labor cost per cu. yd. for mixing and placing concrete should be somewhat less on a pipe with 1 cu. yd. per lin. ft. than on one with ½ cu. yd. or less per lineal foot. [The Pinto pipe is 5.25 ft. diameter, having 0.44 cu. yd. per lin. ft.—Editors.] Another thing, it should be apparent to any one that the only reasonable basis for comparison of costs of moving forms and setting reinforcement is per lin. ft. moved and set instead of per cubic yard. This proposition needs no argument. [We do not admit this proposition at all. The square foot of area covered by forms is far more to be preferred as a unit than the lineal foot.—Editors.] Again, the character of the forms, and the amount and design of the reinforcement vary so that it would be a rare case for two jobs to be strictly comparable even on a per lineal foot basis. [Our comparisons were on the yardage basis.—Editors.]

Now to consider the jobs with which you compared this one. First, in your issue of May 9, 1906, a European pipe (of 4.6 ft. diam. and 0.25 cu. yd. per lin. ft.), 88 hours' labor and, say, one-third of a foreman, mixed and placed 17 cu. yds. of concrete in 60 ft. of pipe per day. At the wages paid on the Pinto pipe this cost would be:

88 hours labor at $0.3125	$27.50
One-third foreman, say	1.25
	$28.75

$1.69 per cu. yd. equals, say $0.40 per lin. ft. At Pinto the gang mixed and placed 766 cu. yds concrete in 1,723 lin. ft. or about 17 cu. yds. in 40 lin. ft. of pipe per day at a cost including foremen of $2.17 per cu. yd. or $0.96 per lin. ft.

On the European pipe it cost (at Pinto wages and a proportion of the foreman) for moving forms and placing reinforcement and finishing pipe:

77 hours labor at $0.3125	$24.06
Foreman	1.25
	$25.31

Or $0.367 per lin. ft. equals 38 per cent of the Pinto cost. Pinto cost for equivalent work was $0.96 per lin. ft. Bear in mind that the European job was favored by extraordinarily quick-setting cement and an inside form, which with such cement would be more economical than the Pinto form; also that at Pinto about four times the weight of reinforcement was used per lin. ft. of pipe as in the European job. [Labor on the European pipe cost $3.18 per cu. yd. as compared with $5.53 at Pinto, for mixing and placing and for form work.—Editors.]

The writer has not at hand the other issues of ENGINEERING CONTRACTING referred to. [Aug. 22 and Oct. 10, 1906, and Feb. 20, 1907, contain costs of reinforced pipe work, all confirming our position.—Editors.]

In Gillette's Handbook of Cost Data, page 365, a 9-ft. 10-in. by 6-ft. reinforced concrete sewer at Kalamazoo contained 0.95 cu. yds. per lin. ft. Mixing and placing, reduced to Pinto wage, cost $2.19 per cu. yd. to Pinto's $2.17. Moving and setting forms on same basis cost $0.615 per lin. ft. to Pinto's $0.744. It is there noted that that cost for moving and setting forms is "unnecessarily high"; possibly, but that is an undemonstrated opinion. [The labor on the Kalamazoo sewer cost $3.58 for the same sort of work that cost $5.53 per cu. yd. on the Pinto work. A lineal foot comparison is wholly erroneous when one pipe is so much larger than the other.—Editors.]

The next case, Gillette's Handbook, page 366, is a 9¼-ft. sewer at Wilmington, containing 1 cu. yd. per lin. ft., principally machine mixed. Mixing and placing reduced to basis of Pinto wages cost $1.65 per cu. yd. or 76 per cent of cost at Pinto. Cost of moving and setting forms and reinforcement for this 9¼-ft. sewer is there given as 4½c per lin. ft., which statement is absurd on its face. Near the bottom of page 369 the cost is given differently—i. e., 9c per lin. ft. The figures appear to be carelessly compiled, or else there was a false distribution made by the cost keeper. [Here again our correspondent errs, both in assuming that a cost is "absurd" because it is so much lower than his own records, and in assuming that the figures were "carelessly compiled." There is no disagreement between the figures of cost given. The bottom of page 369 does *not* give the cost of moving forms at 9 cts. per cu. yd., but at 2 cts. per cu. yd. of invert and 7 cts. per cu. yd. of arch, which is 4½ cts. per cu. yd. of entire sewer. The total labor on this Wilmington sewer was $1.83 for the same work that cost $5.53 at Pinto.—Editors.]

Next case, Gillette's Handbook, page 371: A 13½-ft. sewer at Cleveland, containing 2⅛ cu. yds. per lin. ft. with reinforcement only in top of side walls and arch. The handbook is evidently twisted when it gives 13 cu. yds. in 40 ft. of invert and side walls and 72 cu. yds. in 40 ft. of arch. [The handbook gives the unit costs correctly, but the length of sewer (40 ft.) is incorrectly given.—Editors.] However, the mixing and placing reduced to basis of Pinto wages cost $1.29 per cu. yd. or about 60 per cent of Pinto, bearing in mind that there was about five times as much concrete per lin. ft. as at Pinto and that for 80 per cent of this there was no reinforcement to bother with. Moving and setting forms and reinforcement reduced to basis of Pinto wages cost $0.70 per lin. ft. as compared with $0.96 at Pinto. [Here again our correspondent makes an unfair comparison when he uses the lineal foot as the unit, since the Cleveland sewer is 2½ times as large as the Pinto pipe.—Editors.]

Next case, Gillette's Handbook, page 374; cost of a 5-ft. concrete steel conduit at Cedar Grove. This is the case most nearly comparable to Pinto as regards size and design. There was 0.8 of a cu. yd per lin. ft. Cost of mixing and placing, reduced to basis of Pinto wages, was $2.46 per cu. yd. or $0.29 more than at Pinto. Moving forms on same basis cost $0.85 per lin. ft., as against $0.74 at Pinto. Placing 11 pounds of reinforcement per lin. ft. cost on same basis $0.10; at Pinto 43 pounds per lin. ft. cost $0.21. [The labor cost was $3.58 per cu. yd. for the same work that cost $5.53 at Pinto.—Editors.]

Next case, Gillette's Handbook, page 381, the Jersey City conduit. The figure on page 382 shows a section about 8½ ft. diameter containing about 18.8 cu. ft. or 0.7 cu. yd. per lin. ft. Reinforcement only in the sidewalls and arch; concrete machine mixed. The cost is not divided among the various items, the total only of 380 hours' labor for 40 lin. ft. being given. At the prices paid at Pinto, nothing added for foreman, this would equal $2.97 per lin. ft. or $4.26 per cu. yd., which cannot be considered cheaper than the Pinto figures of $2.46 per lin. ft. or $5.53 per cu. yd. [The Pinto job cost nearly 30 per cent more per cu. yd.—Editors.]

The foregoing are the jobs (lacking three—Editors.) which you say (Nov. 6) "not one of which begins to equal the $6 per cu. yd. for labor on the work under discussion" and "several of the examples show a labor cost per cubic yard considerably less than half what this work cost the government."

Following are a few considerations which apply to the construction of the Pinto pipe, also more or less to all the work of the Reclamation Service, and which I recommend to the attention of your editorial writer.

The work was miles from any railroad, shop, store, or labor market. The temperature was 100° to 115° in a tent on the job. What it may have been on the mixing board is a matter of conjecture; but the writer has observed a temperature of 158° in water drawn from a pipe line covered with 6 ins. or so of earth.

What is the probable efficiency of labor in that temperature? The labor was poor; the gang of 25 or so employed represented just about 10 per cent residue obtained by sifting.

Regarding the character of labor in this part of the country, Mr. John E. Field states the case accurately in his letter in your Dec. 4 issue. The best labor to-day in Arizona, as a class, is the Apache Indian; of all the rest, not one man in ten would hold a job fifteen minutes in the east.

Any man contracting to build the Pinto pipe would have to figure on using that kind of labor.

There are jobs waiting today with the Reclamation Service, as well as with every large contractor in the country, for a foreman who can equal the record made at Pinto under the circumstances.

You may have heard that the value of a statistician depends on his freedom from bias, on his not having any theories to substantiate in compiling his figures. Would it not strike an impartial observer, that your assertions in this case at least were hasty and ill considered, and that you betrayed too much anxiety to find a text for your sermon?

In the heroic final paragraph of your editorial of Sept. 18, occurs an amusing phrase, i. e., "the wasteful day labor system." Considering that contractors do their work by that same system, why do you not proclaim your belief (as evidenced by that phrase) in something like the following words? Engineers as a class are unintelligent, inefficient, and not interested to keep down the cost of work; contractors as a class are intelligent, efficient, striving to keep down the cost of work, and satisfied with a reasonable profit.

Chester W. Smith,
Constructing Engineer, U. S. R. S.
Roosevelt, Arizona, Dec. 11, 1907.

[Whether our criticism of the astonishingly high cost of this "Pinto Pipe" was justified or not, readers having the back files of Engineering-Contracting can readily judge. Our correspondent would do well not to seek excuses for his high costs by using such illogical units as the lineal foot for comparative purposes. Nor have we ever claimed that the cubic yard is the only satisfactory unit of comparison. The branding of a cost as "absurd" because it is very low, is scarcely evidence nor argument.

There are two systems of doing public work, "the day labor system" and "the contract system." Our correspondent surely ought to know the meaning of the expression "day labor system" in this connection. A definition can hardly be attached to every common phrase.

Engineers often make very successful contractors, showing that their failure to secure economic results when in charge of day labor jobs is not the fault of the man so much as it is the fault of the system. No superintendent is likely to be so keen to save a dollar for Uncle Sam as to save it for himself. But, even if he were, he would find an apathy among the workmen on Uncle Sam's payroll that is well illustrated in this very job at Pinto, making due allowance for local conditions.—Editors.]

Comment on "a High Cost for Excavation with Carts."

Sirs: Referring to your article, "A High Cost for Excavation with Carts," in your issue of Jan. 22, I wish to tell you what I would have done. A foreman may not know anything about cost records, but seeing that his gang had to wait quite often for carts, he would go to his employers and ask for two more carts. On learning that there were no more carts to be had, he would go back, and, although he is an ambitious foreman and, therefore, hates to decrease his gang, he will not run the risk of having the superintendent tell him that he has too many men, and he will therefore let one shoveler and one picker go, and thus find out that his force is now better balanced and turning out the same amount of work (5 shovelers at 14 yards and 3 pickers at 23⅓ cu. yds. being a fair day's work).

I am not a non-believer in cost records (I only wish I knew a little more about the art), but I do not quite agree with the writer of this article.

Two sets of carts at $4.50 is $9 giving, for 70 cu. yds., 12.9 cts. per cu. yd. and not 11 cts. This destroys the whole reasoning of the author, as this is exactly what the hauling ought to cost. But by looking over his figures once more he would see that his picking and shoveling cost too much and therefore either increase the number of carts or decrease the number of men. When two sets of carts were overworked hauling 70 cu. yds. or 35 cu. yds. each, it is rather astonishing to see three sets of carts hauling 112 or 37 cu. yards each. Yours truly,

Lynbrook, N. Y., J. M. Jergenson.

[Our correspondent calls attention to the seeming error in the cost of hauling in the article in question. The 11 cts. for hauling is correct as given, but the statement that four carts were used was only a general one, as there was some lost time for the carts. The teams were hired and it was not always possible to have them make a full day. The 11 cts. was derived by dividing the total amount paid for cart hire by the number of cubic yards excavated. At a cost for hauling of 11 cts. per cu. yd. it is evident that each set of carts hauled nearly 41 cu. yds., making 20½ cu. yds. per cart. For three sets of carts to have hauled 112 cu. yds. would have meant a little less than 19 cu. yds. per cart. Under these circumstances we feel that the views set forth in our article are entirely correct.

A foreman is a workman to handle certain tools for his employer. In this case these tools were men and carts. It is his part to get the best work possible from the tools given to him. Unless men are incompetent or unruly, a foreman has no right to discharge them. Laborers are frequently more difficult to obtain than foremen. In the case in question, the grading was being done when men were scarce, and it cost from $10 to $15 to get a new man on the job. It was for the contractor or his superintendent to decide whether or not the men should be dropped, and the contractor would decide, as was done in this case, that it would be better to work to a disadvantage for a few days, and hold the men, rather than to discharge them.—Editors.]

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review, timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are: First, to inform civil engineers and contractors of the articles and papers of merit, that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING-CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in., 15 cts.
American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.
American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y., m; 7x10 in.; 20 cts.
American Engineer and R. R. Journal (Am. Engr. & R. R. Jl.), York, N. Y.; m; 7x10 in.; 20 cts.
American Gas Light Journal (Am. G. L. Jl.), New York, N. Y.; w; 10x13 in.; 10 cts.
American Machinist (Am. Mchst.), New York; w; 7x10 in.; 15 cts.
Annales des Ponts et Chaussees (An. P. & C.), Paris, France; m.
Architects and Builders Journal (Arch. & Bldrs. Jl.), Baltimore, Md.; m; 9x12 in.; 20 cts.
Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.
Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
Bulletin International Railway Congress (Bul. Int. Ry. Cong.), Brussels; m; 50 cts.
Bulletin U. S. Geological Survey (Bul. Geo. Surv.), Washington, D. C., 4x7 in.
Bulletin U. S. Department of Agriculture (Bul. Dept. Agr.), Washington, D. C.; 4x7 in.
Bulletins Railway Engineering & Maintenance of Way Association (Bul. Am. Ry. Eng. & M. of W. Assoc.).
California Journal of Technology (Cal. Jl. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.
Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x10 in.; 20 cts.
Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.
Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.
Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.
Canadian Mining Journal (Can. Min. Jl.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.
Canadian Municipal Journal (Can. Mun. Jl.), Montreal, Que.; m; 6¾x10 in.; 10 cts.
Carpentry and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.
Cassier's Magazine (Cas. Mag.), New York, N. Y.; m; 5x8 in.; 25 cts.
Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.
Cement Age (Cem. Age), New York, N. Y.; m; 4x7 in.; 10 cts.
Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.
Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.
Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.
Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.
Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.
Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.
Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.
Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.
Concrete and Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.
Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.
Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.
Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.
Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.
Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.
Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.
Electric Railway Review (Elec. Ry. Rev.), Chicago, Ill.; w; 7x10 in.; 20 cts.
Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electric Traction Weekly (Elec. Trac. Wkly.), Cleveland, O.; w; 7x10 in.; 10 cts.
Engineer (Engr. Lon.), London, England; w; 4x11 in.
Engineer, (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Engineering (Eng.), London, England; w; 8x11 in.
Engineering Digest (Eng. Dig.), New York, N. Y.; m; 5x8 in.; 20 cts.
Engineering-Contracting (Eng.-Contr.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Engineering and Mining Journal (Eng. & Min. Jl.), New York, N. Y.; w; 7x10 in.; 15 cts.
Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.
Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.
Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.
Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.
Le Genie Civil, Paris, France; w.
Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.
Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.
Industrial World (Ind. Wld.), Pittsburg, Pa.; w; 7x10 in.; 10 cts.
Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; $1.
Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.
Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.
Iron Trade Review (Iron T. Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.
Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.
Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.
Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.
Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.
Journal of Electricity, Power and Gas (Jl. Elec., P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.
Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.
Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.
Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Mines and Minerals (Mi. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.
Mining and Scientific Press. (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.
Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.
Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Modern Machinery (Mod. Mchy.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Municipal Journal and Engineer (Mun. Jl. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.
Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.
Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.
Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w; 9x11 in.; 15 cts.
Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.
The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 ins., 15 cts.
Power, New York, N. Y.; m; 7x10 in.; 20 cts.
Proceedings American Institute of Electrical Engineers (Proc. Am. I. of E. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings American Society of Civil Engineers (Proc. Am. Soc. C. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings American Society of Mechanical Engineers (Proc. Am. Soc. M. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings Engineers' Club of Philadelphia (Proc. Engrs.' Club, Phila.), Philadelphia; qr.; 4x7 in.; 25 cts.
Proceedings Canadian Society of Civil Engineers (Proc. Can. Soc. C. E.), Montreal; m; 4x7 in.; 50 cts.
Railroad Gazette (R. R. Gaz.), New York; w; 8x11 in.; 15 cts.
Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.
Railway Age (Ry. Age), Chicago, Ill.; w; 7x10 in.; 10 cts.
Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.
Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.
Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.
Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Roadmaster and Foreman (Rd. & For.), Chicago, 7x10 in., 10 cts.
Rock Products (Rk. Prod.), Chicago, Ill.; bi-w.; 9x11 in.; 10 cts.
Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.
School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr.; 4x7 in.; 30 cts.
Schweizerische Bauzeitung, Zurich; w.
Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.
Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.
Sibley Journal of Engineering (Sib. Jl. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.
Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.
Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.
Street Railway Journal (St. Ry. Jl.), New York, N. Y.; w; 7x10 in.; 10 cts.
Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.
The Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.
Waterproofing (W. P.), New York, N. Y.; m; 5x8 in.; 10 cts.
Zeitschrift d. Oest. Ing. u. Arch. Ver., Vienna; w.
Zeitschrift d. Ver Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

Data on Oiling Park Roadways at Kansas City, Mo. Engr. Contr., Jan. 22, 1908; 2-3 p.

Describes materials used and methods followed in oiling some 375,000 sq. yds. of roadway and gives itemized cost of the work. The average cost was 0.08 ct. per sq. yd.

Data on Street Cleaning at St. Louis, Mo. Engr. Contr., Jan. 15, 1908; 1-3 p.

Contains data on cost of street cleaning by flushing, hand cleaning and machine sweeping.

Reinforced Concrete Foundations Over Excavation on Paved Street. By John McNeal. Proc. Am. Soc. C. E., December, 1907; 2 pp.

Describes the use of expanded metal in the concrete foundation of street pavements to prevent the settlement of the pavement from excavation and back filling that have been done under it. The construction is in use at Easton, Pa.

Roadway Widths and Excavations. By Stephen Child, Mun. Jl. & Engr., Jan. 1, 1908; 2 pp.

An article suggesting the advantages of wide streets, with narrow paved section.

Street Lighting in 1907. By Alton D. Adams. Mun. Jl. & Engr., Jan. 1, 1908; 3 pp.

A review of the progress in street lighting in England and America during the year. Contains information on the types of lamps used, and English practice.

Municipal Lighting in Detroit. By William M. Daly. Mun. Jl. & Engr., Jan. 1, 1908; 2 pp.

Gives figures on the operation of the municipal electric light plant of Detroit, Mich., showing value and cost of services rendered.

Municipal Asphalt Pavement Repair Plant, New Orleans, La. Eng. News, Jan. 2. 1908; 1 p.

Describes briefly from the report of the City Engineer for 1907 the character of the plant and the conditions which led to its adoption. The prices paid for asphalt pavement materials are given with itemized cost of the plant and special and general operating charges for the year ending Aug. 31, 1907. The cost of repairs was 11.44 cts. per sq. yd., not including interest and depreciation.

Road Preservation Experiments. By Charles W. Ross. Good Roads, January, 1908; 1½ pp.

Gives methods and some cost data on experiments in dust-laying and road preservation at Newton, Mass. The roads were treated with Tarvia, "asphaltoilene" and Texas oil.

Materials for Filling Joints of Brick Pavements. By W. A. Howell. Good Roads, January, 1908; 1 p.

A paper read before the 1907 convention of the American Society of Municipal Improvement. Gives the results of some tests made at Newark, N. J., to determine the best bituminous grout to be used for filling joints of brick pavement.

Split Log Drag Competition in Canada. Good Roads, January, 1908; 2 pp.

Describes the use of the split log drag in road improvement work and gives notes brought out by a recent competition on the practical use of the drag.

SEWERS.

Notes on Sludge Disposal. By Geo. W. Fuller. Eng. Rec., Jan. 18, 1908; 1 1-3 p.

Suggestions as to the care of sewage disposal plants, taken from a paper to be published with the report for 1907 of the New Jersey Sewerage Commission.

Cameron Septic Tank Patent Decision. Eng. News, Jan. 23, 1908; 2½ pp.

Full text of the decision of the U. S. Circuit Court of Appeals declaring valid the "process claims" of the Cameron Septic Tank Co., and denying the apparatus claims.

Sewage Disposal at Worcester. Mun. Jl. & Engr., Jan. 22, 1908; 3½ pp.

General article illustrating and describing the chemical precipitation sewage disposal plant of Worcester, Mass., and giving data on its operation in 1906.

Lawrence Experiment Station. Mun. Jl. & Engr., Jan. 15, 1908; 3 pp.

An illustrated article giving a general review of the work done during the past 20 years by the Lawrence experiment station of the Massachusetts State Board of Health.

GARBAGE AND CITY WASTES DISPOSAL.

Garbage and Refuse Disposal at Milwaukee, Wis. Eng. News, Jan. 16, 1908; 2 pp.

Abstracts report of Rudolph Hering, reviewing history and present status of refuse collection and disposal in Milwaukee, Wis., and making estimates and recommendations for dealing with garbage and refuse in the future. Valuable figures of the composition and calorific power of Milwaukee garbage determined specially for the report by analyses and tests are given. Estimates of first cost, operating cost and revenue of two plants of 200 tons and 450 tons daily capacity are presented. This report has been printed in full in the proceedings of the Common Council of Milwaukee for Dec. 23, 1907.

WATER-WORKS AND HYDRAULICS.

Flow of Water Through Submerged Tubes. By C. B. Stewart. Eng. News, Jan. 9, 1908, 3 pp.

Abstract of a bulletin issued by the University of Wisconsin, giving results of experiments on flow through submerged tubes 4 ft. square. Drawings of testing plant, diagrams showing various arrangements of tube lengths and entrance conditions, and a diagram for the graphical solution of equations $Q = Ca \quad 2gh$ and $Q = av$ are given. The paper is a valuable one.

Stream Flow Data From a Water Power Standpoint. By Charles E. Chandler. Jl. N. E. W. W. Assoc., December; 15 pp.

The records of the stream flow of the Croton River, New York, for 38 years are given in detail, and their value shown. A comparison is made with the flow of other streams over long periods of time. A paper of value to water power engineers.

Methods of Pumping Deep Ground Waters. By Charles B. Burdick. Jl. Wn. Soc. C. E., December, 1907; 37 pp.

Presents the principles of well flow and describes the several methods of pumping practiced including air lift pumps, shaft and tunnel methods, and vertical shaft high speed centrifugal pumps. Tests of pumps are given. An excellent summary of deep well pumping methods.

The Waltham Reservoir. By Bertram Brewer. Jl. N. E. W. W. Assoc., December, 1907; 8 pp.

This reservoir is of concrete 35 ft. high and 100 ft. in diameter. Capacity 2,000,000 gallons. The largest reservoir of this character in the world. The construction details are described and illustrated, and the waterproofing of the reservoir is discussed.

Appraisal and Depreciation of Water Works and Similar Properties. Jl. Assoc. Eng. Soc., December, 1907; 31 pp.; discussion, 15 pp.

A discussion of the factors to be considered and the methods to be adopted in appraising water-works and similar public service industries. A valuable table compiled from various sources is given, showing life in years and per cent. annual depreciation of electric light systems, water-works, bridges, buildings, machinery, materials, tools, etc. The paper and discussion make a valuable contribution to this interesting subject.

Discharge of Water From Minute Orifices. By W. R. Baldwin-Wiseman. The Surveyor, Jan. 10, 1908; 1½ pp.

Gives the results of experiments conducted by the author to determine the discharge of water at different pressures from circular orifices of extremely small diameter piercing pipes of moderate thickness. The author found that the coefficient of discharge seemed to vary more or less directly with the ratio of the thickness to the diameter of the orifice.

The Talla Water Supply, Edinburgh, Scotland. Eng. Rec., Jan. 4, 1908; 1 p.

A description of the new dam and aqueduct, that gives an additional supply of water to this city. The design of the dam is illustrated, and the method of construction given.

Underground Water—The Right of User in the Light of Recent Enactments. By Alfred B. E. Blackburn. The Surveyor, Jan. 3, 1908; 3 pp.

The article deals with the rights of the user of underground water as affected by the recent enactments of English Parliament. The law recognizes two different conditions with regard to underground: (1) Water flowing in a known and defined underground channel, and (2) water not flowing in any known or defined underground channel. Three cases of land ownership with regard to the legal right of user of underground water are considered: That of the ordinary landowner, that of a water company, and that of a railway company.

The Croton Falls Reservoir, Croton Water System, New York. Eng. Rec., Jan. 18, 1908; 2 pp.

Describes the need for this reservoir and the work necessary to construct it, giving some details of plans.

IRRIGATION AND DRAINAGE.

Sluice Gates for Pathfinder and Shoshone Dams. By F. W. Hanna. Eng. News, Jan. 2, 1908; 2 pp.

Gives general description of construction and operation of gates working under very high heads, 233 ft. in Shoshone dam. General drawings of the gate mechanism are given.

Notes on Rainfall at Savanah, Ga. By J. de Bruyn-Kops. Proc. Am. Soc. C. E., December, 1907; 9 pp.

Data on the rainfall at that point given to show how the rainfall affects drainage work done by engineers.

Excavation Table for Ditch Work. Engr. Contr., Jan. 22, 1908; 1-3 p.

Includes a table of prices for excavating, laying tile, and back-filling trench.

Ditch Construction in Alaska. Engr. Contr., Jan. 8, 1908; 2-3 p.

Describes methods of constructing ditches in connection with hydraulic mining work in Alaska.

RAILWAYS.

Railway Weed Burning Machine Using Gasoline as Fuel. Eng. News, Jan. 2; 2-3 p

Describes weed burning machine built by the Commonwealth Steel Co., St. Louis, Mo., for Union Pacific Ry., with figures of capacity, operating force required and cost of operation. Two trips of the machine are required to kill the weeds; average cost of two trips is given as $5.40 per mile.

Practical Aspects of Steam Railroad Electrification. By W. N. Smith. Proc. Am. Inst. E. E., January; 16 pp.

Points out and discusses briefly the various problems, aside from electrotechnical problems, that have to be considered in electrifying steam railways. Financial and economic considerations, construction and maintenance problems and transportation questions are outlined briefly. The article is one that the civil engineer can understand and of which he will appreciate the force.

Comparative Performance of Steam and

Electric Locomotives. Ry. & E. Rev., Dec. 28, 1908; 1 1-3 pp.

A discussion by Max Toltz of a paper on this subject by Albert H. Armstrong. The former makes a comparison by cost of operation, and asserts that with certain improvements in locomotives, the electric motor will not yet displace them, for economic service.

Pennsylvania Railroad Improvement at Blairsville, Pa. By G. W. Philips and J. Gwilliam. Eng. Rec., Jan. 4, 1908; 3 1-3 pp.

This article describes and illustrates in detail the work that was done between Blairsville and Tunnelton to improve the line between those points.

Statistics of Railway Building in 1907. Ry. Age, Dec. 27, 1907; 5 pp.

States that the number of miles of railway built during the year was 5,874. Gives table showing number of miles built in each state and also in each group of states. Louisiana leads with 422 miles, and the northwestern states have built more than any other group, namely 1,170 miles. A detail statement of track laid by states and lines is also given.

Block Signals on American Railways. Ry. Age, Dec. 27, 1907; 2 pp.

Statistics showing the number of installations and the kind of block signals that were installed on American railways during the year 1907.

The Galesburg Timber Preserving Plant of the Burlington. R. R. Gaz., Jan. 10, 1908; 2 pp.

Describes the storage yard around the plant, and also the plant. The construction features of interest were the building of the main building and the foundation of the large tanks of reinforced concrete.

Arrangement of Railroad Shops. R. R. Gaz. Jan. 10, 1908; 4 pages.

A paper presented before the Canadian Railway Club by Geo. A. Damon. A paper of interest to railroad and industrial engineers, as it deals with the subject in a broad way, and several actual layouts of yards and shops are given. Size and equipment of shops, and their cost are commented upon. Arrangement of buildings is dependent upon the routing of the work through the shops.

The Value of Tie Preservation. R. R. Gaz. Jan. 10, 1908; ½ p.

Speaks of the extent to which ties are being treated for preservation, and shows value of treatment by an example of the cost of treated and untreated ties, giving the life of each.

The Influence of Heat Value and Distribution on Railroad Fuel Cost. R. R. Gaz. Jan. 10, 1908; 2½ pp.

A paper presented before the Western Railway Club by J. G. Crawford. The importance of the subject is shown by the fact that locomotive fuel is 12 per cent of the total operating expenses of railroads. The need of testing the quality of coal and the tests to use are set forth. The heat value obtained, consideration is then given to equal and unequal heat value, source of supply (distance to be hauled) and price, showing how these factors will effect the selection of coal.

Locomotive and Car Shops. Ry. Eng & M. W. January, 1908; 8 pp.

A detail description of the layout and general design of the shops of the Kansas City Southern Ry. at Pittsburg, Kan. Plans of the yard and of many of the buildings are given.

Proposed Rail Section. Ry. Eng. & M. W. January, 1908; 2 pp.

Line drawings of sections and dimensions and weights of rails recommended by the Committee on Rail and Wheel Sections, of the American Railway Association, are given in this article; 80, 90 and 100 lbs, sections are illustrated.

The Car Wheel. By George L. Fowler. Proc. Ry. Clb. Pitts. 32 pp.

A paper read at the Nov. 22 meeting of this club describing tests and results showing the lateral thrust of a car wheel on a curve when in motion. Also tests to develop and decide upon a steel wheel suitable for high capacity cars, as satisfactory as that of a first-class steel tired wheel.

Structural Features of the Warwick Shops of the Lehigh & Hudson River Ry. Eng Rec. Jan. 11, 1908; 2 1-3 pp.

Description of the structural steel work design and erection. The entire framework is of steel, but the walls are made of 2½ ins. of concrete plastered on metal framework.

Rail Specification, American Railway Association. Ry & Eng. Rev., Dec. 28, 1908; 1 1-3 pp.

Report of committee appointed by this association is given in detail. To this report Mr. J. Kruttschnitt dissented, he making a minority report, which is also given in detail. A page editorial also appears in this issue on the subject.

Roadbed and Terminal Improvements, Baltimore & Ohio R. R. Ry. & Eng. Rev. Dec. 28, 1908, 2 pp.

A description of the improvements made on the main line between Davis and Hollofields, Md., with remarks on the character of the excavation and methods used. Also description of east bound freight yard built at Brunswick, Md., showing extent of yard and improvements.

The Car Wheel and Its Relation to the Rail. Ry. & Eng. Rev. Jan. 25, 1908; 3 2-3 pp.

Abstracted from a paper by S. P. Bush, read before the Western Railway Club. It is shown that most wheels fail by parts of the flange breaking off. Tests, made at Purdue University to show what this breaking load is, are described and their results given. The parts covered are to improve the quality of the wheel; improve the contour of the wheel and the rail; modify the break practice, and so change truck construction that in the lateral motion of the flange against the rail there will be a yielding resistance, rather than an abrupt one. A discussion of these various relations leads up to their recommendation.

Symposium of Railway Conditions and Problems. Ry. Age, Dec. 27, 1907; 16 pp.

This paper recently sent a number of questions to governors of states, railway commissioners, and railroad officials, asking for replies. The questions dealt with the conditions and problems that have been under discussion in the daily press and before legislative bodies during the past year. The article gives the various replies received.

Statistics of Cars and Locomotives Ordered in 1907. Ry. Age, Dec. 27, 1907; 6½ pp.

Tables showing kind of equipment bought, the purchaser, the number in each order, the capacity or size of cars or locomotives, and the name of the builder. A table is also given showing a comparison with six preceding years. During 1907, 3,482 locomotives, 1,791 passenger cars and 151,711 freight cars were purchased.

Interlocking Plant, Hoboken Terminal Yard, D., L. & W. Ry. Eng. News, Jan. 30, 1908; 5 pp.

Elaborate general description of interlocking signal plant comprising 36 sets of switches and 110 signals.

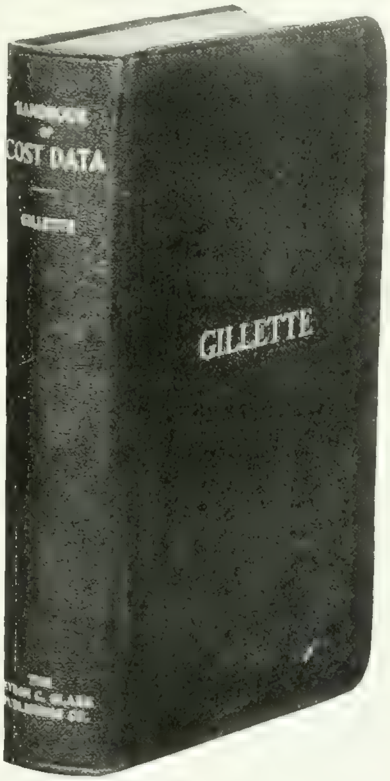
Railroad Construction in the Philippine Islands. By L. F. Goodale. Ry. Age, Jan. 31, 1908; 5½ pp.

A general descriptive article on the character, extent and methods of construction of railway work being done in the Philippine Islands. Drawings are given of station buildings and section houses, etc. The article is worth reading.

Handbook of Cost Data

By HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting"

"Costa Data" has broken all records for the sale of technical books. Over 10,000 copies were sold in less than two years; 1,600 in last three months. The book has over 600 pages of actual costs taken from the private records of engineers and contractors, and so itemized and analyzed as to be of inestimable value to any person who has to do with making bids and estimates or in checking estimates. This covers the whole field of contract work, giving the cost of labor and materials required for every kind of construction from the laying of sod to the building of reinforced concrete sewers. No detail of contract work has been too small to be described and recorded. Wages and prices of material are given in every case, so that proper substitution can be made where conditions differ. It gives also valuable data on methods of construction, thus enabling foreman to handle work in the most economical manner possible.



The general headings are:

- Cost-Keeping, Preparing Estimates, Organization of Forces, etc.
- Cost of Earth Excavation.
- Cost of Rock Excavation, Quarrying and Crushing.
- Cost of Roads, Pavements and Walks.
- Cost of Stone Masonry.
- Cost of Concrete Construction, all kinds.
- Cost of Water-Works.
- Cost of Sewers, Vitrified Conduits and Tile Drains.
- Cost of Piling, Trestling, Timberwork.
- Cost of Erecting Buildings.
- Cost of Steam and Electric Railways.
- Cost of Bridge Erection and Painting.
- Cost of Ry. and Topographic Surveys.
- Cost of Miscellaneous Structures.

24 Page Circular, showing Contents and Sample Pages, will be mailed FREE on request.

THE MYRON CLARK PUBLISHING CO.
355 Dearborn St. Chicago

ELECTRIC RAILWAYS.

Methods and Cost of Transmission Line Construction for Interurban Electric Railways. By E. P. Roberts and J. C. Gillette. Eng.-Contr., Jan. 1, 1908; 3 pp.

Describes methods of catenary line construction and materials used and gives itemized estimates of cost of single and double track construction. A notably interesting article to electric railway engineers.

Electric Railway Rolling Stock Ordered in 1907. Elec. Ry. Rev., Jan. 4, 1908; 3 pp.

A detailed statement of all equipment purchased, showing purchaser, class, and builder, and a comparison of the total amount with that ordered in 1906.

Tracklaying on Indianapolis & Cincinnati Traction System. St. Ry. Jl., Jan. 18, 1908; 1 p.

Describes very briefly method of tracklaying by which gang of 20 men laid 1¼ miles of track in 7 hours.

Concrete and Steel Tie Electric Railway Track Construction. By H. L. Weber, St. Ry. Jl., Jan. 18, 1908; 2 pp.

Sections of proposed track construction with concrete beam, wood, steel or old rail ties and concrete reinforcement under joints, are given and estimates presented of cost per lineal foot of track. Costs and drawings are also given of wooden ties on rubble concrete base at Ft. Wayne, Ind.

Track Reconstruction in San Francisco. St. Ry. Jl., Jan. 18, 1908; 5 pp.

Shows views of derrick car and crusher plant and briefly describes use of them in tearing out old yokes and concrete and recrushing concrete for future use. Very brief and general.

Overhead Construction for High Tension Electric Traction or Transmission. By R. D. Coombs. Proc. Am. Soc. C. E., December, 1908; 33 pp.

This subject is discussed in great detail, both as to design and construction. Formulas for wind loads are given and discussed, also for catenary stresses. Tables are given showing strength and vertical and horizontal loads that steel, copper and aluminum wires will carry. Diagrams are given of two-anchor insulators. Specifications are given for this work. The subject is treated under the two distinct heads, transmission and electric traction. Span and bracket construction are shown by drawings of structural steel on concrete foundations. This paper is of interest to both civil and electrical engineers.

TUNNELS AND SUBWAYS.

Method and Cost of Driving a Short Tunnel for a Sewer. Eng.-Contr., Jan. 1, 1908; 2 1-3 pp.

A description, illustrated with cuts, is given of the method of driving this tunnel 190 ft. long. The total cost of the excavation and masonry work is given, and also the unit cost of each class of work.

Method of Drilling and Mucking in a Rock Tunnel and a Comparison in Tunneling on the Rand. Eng.-Contr., Jan. 1, 1908; 2 1-3 pp.

The method in detail is described of driving a tunnel 9x9 ft. in the clear, 8,500 ft. long at an average rate of 350 to 375 lin. ft. per month. The method is compared with some rapid work done in the Cinderella mine in the Transvaal.

The Flushing Tunnel for the Gowanus Canal in Brooklyn, N. Y. Eng. Rec., Jan. 11, 1908; 3 pp.

This tunnel is being driven through sand by the shield process. A description of the work being done is given. The contractors' plant, much of which is of special design, and all of which is driven by electricity, is described in detail. An article of interest to contractors and engineers engaged in sewer work.

Air Compressors on New York Tunnel

The world's authority on this great subject.
The most expensive book ever issued and sold for $5.00.

Concrete and Reinforced Concrete Construction

By HOMER A. REID, Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; $5 net, postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete, on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter — material never previously published. This work is complete, up-to-date and original. No other book on concrete contains one-tenth so much of the very latest data on tests, theory and practice.

In a two-column review of this book, "Manufacturers' Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

Write for 16-page Table of Contents.

THE MYRON C. CLARK PUBLISHING CO.
(NOT INCORPORATED)
355 Dearborn St. CHICAGO

Work. By Frank Richards. Com Air. January, 1908; 11 pp.

A description is given of the tunnel plants being used in driving the six tunnels under the North River and the eight tunnels under the East River, now in course of construction or just being completed. The total free air capacity of all the compressors described is 191,291 cu. ft. per minute. Eighty compressors furnish this air, and some of them are among the largest ever built.

BRIDGES AND BUILDINGS.

St. Louis Bridge, Illinois Traction System. St. Ry. Jl., Jan 4, 1908, 1-3 p.

Gives side elevation and brief general description of 8-span electric railway and highway, bridge being built across the Mississippi River at St. Louis, Mo. The bridge has one span of 523 ft., and two spans of 521 ft. each, besides five smaller spans. It is 2,535 ft. long not including viaduct approaches

Experimental Determination of Stresses in Web Plates and Stiffners of Plate Girders. By Prof. F. E. Turneaure. Jl. Wn. Soc. C. E., December, 1907; 32 pp.

Discusses theoretical stresses in web plates; gives results of service tests of 75 ft. plate girder on Chicago & Northwestern Ry.; gives laboratory tests of 16-ft. plate girder at University of Wisconsin. The test results are given in detail with tables and diagrams and general conclusions are presented. A paper of unusual value to designing bridge engineers.

A New Type of Bascule Bridge. Eng. News, Jan. 16, 1908; 4 pp.

Describes new principle of operation for bascule bridges and illustrates and describes operating mechanism for Ohio street bridge at Buffalo, N. Y. In this bridge practically the entire dead load of the bridge is taken away from a vertical reaction on the abutments; friction only has to be overcome in operating the bridge.

Riveted Lattice for Railroad Bridges of Maximum Span; a Plea for a Return to Rational Design. By Geo. H. Thomson. Eng. News, Jan. 23, 1908; pp. 2 1-3.

An interesting argument in favor of a return to riveted lattice construction for railway bridges. The gradual adoption of lattice principles in pin connected bridge work is outlined, the uncertainties of the Eye-bar are explained, and the author concludes that bridges with spans 2,000 ft. and over can be built on the lattice principle of design, and this without risk in erection, without making use of any untried principle or any untried combination of shapes.

Temporary Jackknife Drawbridge Over Bronx River on the New York, New Haven and Hartford R. R. Eng. Rec., Jan. 4, 1908; 2½ pp.

This bridge is built across the river with a skewed channel, and its construction and operation are described and compared with a similar bridge at Pelham Bay, where the channel is at right angles to the bridge. The clear span of the bridge is 50 ft. The skewed channel has the advantage over the square channel, of having to swing the bridge through an angle of only 60° instead of 90°.

A Tall Brick Chimney with Acid Proof Lining. Eng. Rec., Jan. 4, 1908; 1 1-3 pp.

This 366 ft. chimney, the tallest that has been built in this country, is of the Custodis type, and was built at Rochester, N. Y., for the Eastman Kodak Co. Acid fumes go through the chimney, hence its great height to prevent the fumes from being a nuisance in the neighborhood. The hot acid fumes destroy both brick and concrete, so a special lining of brick that have both heat and acid resisting properties was used. Other details of the chimney, and of its construction are described.

CONCRETE AND REINFORCED CONCRETE.

Systematic Analysis of Cost Data. Eng.-Contr., Jan 1, 1908, 2-3 p.

Describes systematic study of cost data at University of Colorado and gives itemized costs of constructing a concrete culvert and a concrete retaining wall, drawing some comparisons.

Cement Testing. By W. J. Bennett. Son. Bld. Rec., February, 1908; 1 1-3 p.

A paper discussing the method and purpose of cement tests and giving a simple and quick test for determining adulterated or blended cements. Some interesting results of accelerated tests are also given.

Experience with Concrete in Fortifications. Eng. Rec., Jan. 25, 1908; 1 p.

From a paper by Major E. E. Winslow, in "Journal of the U. S. Artillery." From experience it was found that concrete was made more impervious to water, if made in sloping layers instead of horizontal layers. Unsuccessful attempts to make the concrete dark, to prevent the glaring effect on the white surface by the sun, are described.

Preservation of Steel Reinforcement in Concrete Structures. Eng. Rec., Jan. 25, 1908; 1-3 p.

Description of tearing down a house built in 1902 of reinforced concrete, in which no corrosion of steel was found unless the rods were protected with less than ¾ in. of concrete. Tide water went over the footing twice daily, yet the steel in them was in a good state of preservation.

Failures of Reinforced Concrete. By H. F. Porter, Cor. Civ. Engr., December, 1907; 9 pp.

Gives reasons for the failure of the Eastman Buildings at Rochester, N. Y. Plainly charges failure to incompetent and careless construction and presents proofs of charges. The article is worth reading.

Reinforced Concrete Railroad Viaducts at Seville, Spain. R. R. Gaz., Jan. 17, 1908; 1 p.

A description of the design and method of construction two reinforced concrete viaducts leading to the wharf of the Spanish Coal & Iron Co

Influence of Bond on Size of Reinforcement Bars for Concrete. By Wm. P. Creager. Eng. Rec., Jan. 25, 1908; 1 p.

A discussion on this subject giving formulas and a diagram showing relation between size of reinforcing bars and unit adhesion. The object of the writer is to provide a rational method of determining the maximum size of bar that can be used in any given span and system of loading, consistent with the adopted working intensity of adhesion or bond stress on the bar.

Conduit of Special Design in Ogden, Utah. Eng Rec., Jan. 18, 1908; 1 p.

A description, illustrated in the plans, showing a covered conduit built at the side of a street to carry a small stream, and from which adjoining land can be irrigated. One side of the conduit serves as a cub and the roof serves as a gutter.

Does Mica Weaken Concrete? By W. N. Willis. Eng. Rec., Jan. 18, 1908; 1-3 p.

Account of tests made on the South & Western R. R. to show that mica occurring in sand lessens the tensile strength of concrete

The Stadium of Syracuse University. Eng. Rec., Jan. 18, 1908; 3 pp.

An interesting account of the designing of the concrete work for this large structure and of the methods used in excavating the earth and doing the concrete work. A general description of the structural features is also given.

Concrete of Exposed Selected Aggregates. By Albert Moyer. Mun. Eng Mag., January, 1908; 5 pp.

Describes and illustrates a monolithic concrete house built at Orange, N. J. The

Cements, Mortars and Concretes
—Their Physical Properties
An up-to-date Compendium of Reliable Tests of Cements, Mortars and Concretes
By
MYRON S. FALK, Ph. D.
Instructor in Civil Engineering, Columbia University.

This book contains a very complete report of the results of tests made during the past fifteen years, and gives these results in tables and diagrams classified according to subjects. This is a reference book that should be in the library of every civil engineer. The contents include chapters on Chemical Properties of Cement, Physical Tests of Cement, General Physical Properties, Elastic Properties in General, Tensile Properties, Compressive Properties, Flexural Properties, Report on Uniform Tests of Cement by the Special Committee of the American Society of Civil Engineers, and Constitution of Cement.

Cloth, 6x9 inches; 184 pages; illustrated; price $2.50 net, postpaid.

Practical Cement Testing
By
W. PURVES TAYLOR, M. S. C. E.
Engineer in Charge of Philadelphia Municipal Testing Laboratories.

This is the first practical and exhaustive treatise on this important subject. It has already been adopted as a text-book by the University of Pennsylvania and other technical schools. Each chapter contains a minute description of the methods followed in the author's laboratory and many valuable suggestions as to the "how" and "why" of cement testing. The observations on the interpretation of results, one of the most difficult tasks of the novice, are especially pertinent and are expressed in a fair and conservative manner.

The book is so complete that it can be put in the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. The wealth of photographs and line cuts furnish the pictorial examples of how to conduct cement tests, and the 300 pages of texts are so explicit that even the most inexperienced man can soon learn the art of cement testing. Yet the book has not a superfluous paragraph. The list of chapters includes: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13) Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement than Portland, (16) Specifications (The Author's, Am. Soc. C. E.; Am. Soc. Test, Mtls.; Soc. Chem. Indust.; Corps Eng. U. S. A.; British Standard, Can. Soc. C. E.).

Cloth, 6x9 inches; 330 pages; 142 illustrations; 58 tables; $3.00 net, postpaid.

The Myron C. Clark Publishing Company
355 Dearborn St., Chicago

house is designed to accord with the natural surroundings and the material employed.

Reinforced Concrete Chimneys. By Sanford E. Thompson. Eng. News, Jan. 9, 1908, 2 2-3 pp.

Abstract of a report made to the Association of American Portland Cement Manufacturers, giving results of investigations into failures of reinforced concrete chimneys, with reasons for these failures, and recommendations for chimney design and construction to avoid future failures. The report charges such failures chiefly to poor material and careless construction. A paper of general value to concrete engineers.

Concrete Lock, Rough River, Ky. Eng. News, Jan. 9, 1908, 1 2-3 p.

Describes briefly the construction of a concrete lock, including excavation, cofferdam work, plant and structures and concrete work proper. The work was done by day labor by U. S. Engineers and unit costs are given for each class of work. Drawings of lock wall forms are shown. The cost of concrete work was $10.72 per cu. yd. Data are lacking for complete analysis of costs.

Analysis of Concrete. By Royal A. Wales. Eng. News, Jan. 9, 1908, ¾ p.

Describes methods adopted by the author in analyzing a concrete of unknown composition to determine the ratio of cement to sand and the ratio of mortar to stone. "The work outlined demonstrates the possibility of analyzing with all necessary accuracy even so uncertain a concrete as that of natural cement."

Reinforced Concrete in Philadelphia Building Code. By Emile G. Perrot. Proc. Phila. Engrs. Club., October, 25 pp.

Presents in full the regulations in the Philadelphia Building Code governing reinforced concrete work. An introduction states the reasons for the various stiplations, formulas, etc., shows the origin, development and method of applying the column and beam formulas, and gives diagrams of bending moment and strength of beams.

Form Details for Concrete Work. By R. H. Haas. Conc. Engr., January, 1809; ¾ p.

Illustrates two styles of slab and girder floor forms and gives a few words of critical comment on each.

Cost of Concrete Foundation Work. Conc. Engr., January, 1908; 1-3 p.

Gives itemized costs of concreting three foundations inside cofferdams; of general value only.

Artistic Treatment of Reinforced Concrete. By A. O. Elsner. Mun. Eng., January, 1908; 3½ pp.

A paper read before the American Institute of Architects. It treats of concrete used structurally, having in view the possibilities of a constructive architecture rather than a mere application of structural decoration.

Concrete Block Silo Construction. Eng.-Contr., Jan. 1, 1908; 1-3 p.

Describes a method of constructing small farmers' silos of blocks molded to curve. The labor cost of constructing such silos is stated to be from 2½ to 4 cts. per block.

Method and Cost of Constructing a 70 ft. Reinforced Concrete Arch Bridge. Engr. Contr., Jan. 1, 1908, 1 p.

The bridge was of the Lutin type, a concrete slab across stream on the bottom tieing together the feet of the arch. The method of construction is described and costs of the various items are given in percentages of the total.

Hydraulic Properties of Reground Cement Mortars. Eng.-Contr., Jan. 1, 1908; 1 p.

Gives series of tests made by Messrs. Henry S. Sparkman and Robert W. Lesley to determine cementing value of reground cement mortars. Tests showed that after cement has been twice mixed with water, hardened and reground, it does not lose all

"I would have given $1,000.00 for this book a year ago."—W. H. Burk, Knoxville, Tenn.

"FIELD SYSTEM"

By FRANK B. GILBRETH, M. Am. Soc. M. E.

WHO THE AUTHOR IS.—Frank B. Gilbreth is the contractor who has made the "cost-plus-a-fixed-sum-contract" famous. In order to handle contract work scattered all over North America, Mr. Gilbreth found it necessary to develop a system whereby his foremen would execute work properly, promptly and economically. The code of rules and instructions to his foremen, and the printed forms for their reports, were bound in book form, and this book Mr. Gilbreth called his "Field System." Mr. Gilbreth's contracts have covered the widest possible range. Railways, canals, dams, factories, office buildings, whole industrial towns, are among the works that he has executed.

WHY ENGINEERS SHOULD STUDY "FIELD SYSTEM."—Every engineer should know how to manage men, for, whether he confines himself to purely professional work or enters into business of executing construction work, his ambition should be to direct the men under him in a manner that will secure the greatest possible efficiency. A revolution in the art of managing men is now in progress. Direct personal supervision was once deemed essential. To-day, however, "system" is fast supplanting personal supervision. By "system" we mean printed or written directions for employes to follow, and daily reports that show what the employes have done. System of this sort has recently been extended to the field survey work of the U. S. Geological Survey. While Gilbreth's "Field System" is not a system for the management of surveys, for example, it is rich in suggestions that can be applied in the management of any kind of field work, whether employes are engaged in surveying or in construction. Its rules and methods are applicable to office work, in so far as the principles involved are concerned. The book, in brief, is a treatise on the science of managing men by system. No engineer who aims to be more than a subordinate can afford not to have this treatise, written by a man who is an acknowledged adept in managing men.

Hundreds of engineers have gone into the contracting business during the past few years, and there is room for thousands more. But if they are to succeed in any great measure, it must be by the intelligent application of system and cost analysis. Gilbreth's "Field System" does not cover the whole field, nor was it written to cover it, but it does cover a very important part of the field, and a part upon which practically nothing has ever been written.

WHY CONTRACTORS SHOULD HAVE "FIELD SYSTEM."—Mr. Gilbreth has done in contracting what Mr. W. L. Douglas and Mr. Marshall Field have done in the mercantile field. He has taken a class of work involving endless detail, and has reduced the handling of these details to a system by virtue of which economy in construction and celerity in performance are secured, regardless of place or men. Every one has heard the expression, "one-shovel contractor," meaning a contractor capable of managing only one steam shovel at a time. The "one-shovel contractor" is the antithesis of the contractor having a system. The "one-shovel contractor" receives daily reports, it is true, but his reporters are his two eyes. The "one-shovel contractor" has a code of instructions for his men, it is true, but his ready tongue is the only leaf of a code bound between the cover of two jaws. The day of the "one-shovel contractor" is not yet gone entirely, but it will pass rapidly away. Every contractor should have a field system of his own, embodying his own experiences and covering his own necessities, but in the developing of such a field system no contractor can afford not to study the work of Mr. Gilbreth.

COPIES OF "FIELD SYSTEM" STOLEN.—When it became generally known that Mr. Gilbreth had supplied his foreman and superintendents with printed instructions, copies of the book were bribed from his employes, and photographed page by page, from cover to cover. Other copies were "lost," and thus made way with entirely. Huge salaries were used to hire away Mr. Gilbreth's superintendents, for the purpose of getting not only their trained services, but for their knowledge of the contents of the "Field System."

MAKING THE BOOK PUBLIC.—Mr. Gilbreth's action in making public his "Field System" in its entirety is without precedent in the world of business. It is an act that puts contracting on the high professional level of civil engineering. The civil engineer discloses his method of designing a structure, his purpose being to assist other engineers in doing as well. In the interest of scientific advancement the engineer places on record what he has found to be economic or effective. In the same spirit—we may call it the modern American spirit—Mr. Gilbreth has permitted publication of his private code of instructions to his men—his "Field System." He believes that contractors, and, indeed, all professional business men, will become far more efficient as managers of men if such systems as this are disclosed. He believes that in the general rise of efficiency that will occur all those engaged in business will share. He believes that those who are best fitted to be leaders will remain leaders. Character, experience and ability will have the same relative weight as ever. In these beliefs every broad-minded man ought to concur.

China is a nation that worships "trade secrets." It is a nation of industrial mutes. Their arts and their manufactures are taught by father to son, and zealously guarded. There has been no pyramiding of improvements upon one original invention as a base. The Chinese do not lack inventive ability. They are merely cursed by the curse of secretiveness. Their industries are plastered with signs of "No admittance," and are mummified in consequence. In striking contrast with the Chinese method is the American method. Our doctors, or engineers and our men of science generally have never concealed their discoveries or their improvements. Latterly our business men have shown a recognition of the truth of the general proposition that it pays the individual to share his discoveries with the rest of his fellows. Such generosity, in the final analysis, is simply an enlightened selfishness. The publishers of Gilbreth's "Field System" urgently request other contractors and business men to come forward with their systems, and put them permanently on record. Let business men generally adopt the altruistic policy that actuates professional men, and in its prosperity America will soon rise as far above its present level as it now stands above the level of the Chinese Empire.

PRICE OF THE "FIELD SYSTEM."—The book has 200 pages, bound in leather, and its price is $3 net, postpaid. Order now, before the edition is exhausted.

THE MYRON C. CLARK PUBLISHING CO.

355 Dearborn Street, Chicago

its cementing qualities. A paper of practical interest.

Tests of Bond Between Plain Bars and Concrete. By L. R. Viterbo. Engr. Contr., Jan. 1, 1908; 1 p.

Tests made at Washington University, St. Louis; ½ in. to 1¼ in. round bars embedded 25 times diameter in 1-2-4 concrete; results given in tubular form, discussed and conclusions drawn.

Proposed Traveling Form for Constructing Water Pipe or Sewers. Engr. Contr., Jan. 8, 1908; 1 p.

Mr. F. Teichman, who designed the traveling form used in constructing several thousand feet of large reinforced concrete conduit for the Salt River irrigation works in Arizona, presents conclusions regarding the design and use of traveling forms and gives plans for a proposed form. An interesting discussion of the subject.

Method and Cost of Constructing a Concrete Ribbed Arch Bridge at Grand Rapids, Mich. Eng.-Contr., Jan. 8, 1908; 1 1-3 pp.

The bridge had a span of 75 ft. and consisted of seven parabolic arch ribs carrying columns supporting slab and girder floor. The general methods of construction are described and itemized unit costs given of all parts of the work.

Study of a Design for a Reinforced Concrete Abutment With Some Comparative Estimates of Cost. Engr. Contr., Jan. 15, 1908; 4 pp.

Abstract of a paper by T. M. Fyshe before the Canadian Society of Civil Engineers. Gives adopted formula and general conditions and follows with a full analysis and design of a reinforced concrete abutment some 50 ft. high for 100-ft. span deck plate girder bridge. A useful paper to students as well as to practicing engineers

Spade for Surfacing Concrete. Engr. Contr., Jan. 15, 1908; 1-6 p.

Illustrates and describes briefly a spade with perforated blade for surfacing concrete.

Constructing Wall Forms With Special Plank Holders. Engr. Contr., Jan. 15, 1908; 2-3 p.

Describes and illustrates special plank holder for constructing wall forms without studding or bracing; estimates of cost of form work using plank holders are given for small building.

Method of Maintaining Line Shafting and Machine Operations in Reconstructing a Factory. Engr. Contr., Jan. 22, 1908; ½ p.

Illustrates method of supporting line shafting and replacing old mill floor with reinforced concrete slab and girder floor in factory building.

Proposed Henry Hudson Memorial Bridge at New York City. Engr. Contr., Jan. 22, 1908; 2 2-3 pp.

Report of Mr. Leon S. Moisseiff, Engineer in Charge, to Chief Engineer, Department of Bridges, New York City, advancing arguments to show the feasibility of constructing this proposed 703 ft. span reinforced concrete arch. The several engineering features of the work are presented and the method of handling them is explained.

Recent Experiments in Concrete Pole Construction, With Figures of Cost. Engr. Contr., Jan. 29, 1908; 2 1-3 pp.

Illustrates designs for reinforced concrete trolley line and telegraph poles, giving bills of material and methods of construction with figures of total cost. Gives record of comparative strength tests of 30-ft. reinforced concrete and 30-ft. cedar poles.

Method of Raising Holland Dykes by Coping Walls of Concrete. Engr. Contr., Jan. 29, 1908; ½ p.

Shows section of reinforced concrete coping wall and forms for building it which were used in raising height of earth dyke in Holland. The method of construction is described. Concrete wall cost only 20 per cent. of what raising and widening original embankment would have cost.

Prevention of Cracks in Concrete Construction. By Linn White. Conc. Age., Jan. 15, 1908; 1 2-3 pp.

Gives some data as to spacing of expansion joints and of designing reinforcement to reduce cracks in concrete walls.

Some of San Francisco's Notable Concrete Buildings. By H. F. Stall. Conc. Age., Jan. 15, 1908; 1 pp

Illustrates and describes in a general way several of the notable concrete buildings being constructed in San Francisco.

Reinforced Concrete Construction, Butler Brothers Building. By R. W. Maxton. Conc. Engr., January, 1908; 2½ pp.

The first part of a two-part article describing in a general way the methods of construction with hints for doing work on a large 8-story building.

MATERIALS OF CONSTRUCTION.

Comparative Tests of Hot Rolled and Cold Drawn Steel Bars. By Arthur J. Wood. Eng. News, Jan. 16, 1908; 1½ pp.

Records results of series of tests comparing hot rolled and cold drawn steel bars and compares data with tests on cold rolled steel made by R. H. Thurston in 1902. The tests show, for cold drawn bars, double strength at elastic limit and 10 to 15 per cent. increase in ultimate strength; 5 to 6 per cent. reduction in elongation, and considerable less reduction in area at fracture. Diagrams and a discussion of the tests are given.

Twelve Tests of Carbon-Steel and Nickel Steel, Columbus. By J. A. L. Waddell. Eng. News, Dec. 16, 1907; 3 pp.

Describes tests of three long and three short columns of carbon steel and a similar number of nickel steel columns of identical dimensions and compares results with column tests made by Mr. C. P. Buchanan. (Monthly Review Index, January, 1908.) The author discusses claim that present column formulas are inadequate and gives reasons for contrary belief. The article is a valuable addition to test data on steel columns.

The Lumber Cut of the United States; 1906. Forest Service Circ. No 122; 12 pp.

Gives in detail the amount of lumber cut during 1906, by states, and also tables showing various kinds of timber and their value. The total amount cut was 37,550,760,000 ft., with a mill value of $621,151,388. The value of shingles and laths raised this to $656,796,513.

The Seasoning and Preservative Treatment of Hemlock and Tamarack Cross Ties. By W. F. Sherfesee. Forest Service Circ. No. 132; 31 pp.

Result of experiments carried on by the Forest Service and the C. & N. W. R. R., wherein it was found that this class of ties, which had previously resisted treatment with preservatives, could be treated successfully if allowed to season, and that the preservatives were diffused well throughout the timber.

SURVEYING AND DRAFTING.

Filing and Indexing Office Records. Engr. Contr., Jan. 1, 1908; 43 pp.

A description of methods employed in City Engineer's Office at Providence, R. I.

The Panoramic Camera Applied to Photo-Topographic Work. By C. W. Wright. Trans. Am. Inst. Min. E., January, 1908; 16 pp.

The use of cameras in surveys is old but in this paper is described, the use of a panoramic camera, fitted with spirit levels, a sight alidade, and on the inside of the camera are placed vertical and horizontal scales that are photographed onto the films as the landscape view is taken. This allows of more rapid and accurate work than in the ordinary camera, and for some sur-

Rock Excavation
Methods and Cost
By
HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting."

One superintendent who purchased this book about a year ago writes us that he has cut the cost of his drilling and blasting practically in two since he received the book and applied the methods given by Mr. Gillette. We doubt whether such a statement has ever before been truthfully made of any books except those written by Mr. Gillette. His books are practical books for practical men, and the keynote throughout is economy—how to save money on the work and how to increase the output.

"Rock Excavation" has chapters describing:

Rocks and Their Properties.
Methods and Cost of Hand Drilling
Machine Drills and Their Use.
Steam and Compressed Air Plants.
The Cost of Machine Drilling.
Cost of Diamond Drilling.
Explosives.
Charging and Firing.
Methods of Blasting.
Cost of Loading and Transporting Rock.
Quarrying Stone.
Open Cut Excavation.
Methods and Costs on the Chicago Drainage Canal.
Cost of Trenches and Subways.
Subaqueous Excavation.
Cost of Railway Tunnels.
Cost of Drifting. Shaft Sinking and Stoping.

Cloth, 5½x7 in., 384 pages, 56 figures and illustrations; $3 net postpaid.

Earthwork
And Its Cost
By
HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting."

A book that should be in the hands of every man who is in charge of "moving dirt," whether with pick and shovel, plow and scraper, steam shovel and dredge, or any other tool for digging and conveying earth. The contents include:

The Art of Cost Estimating.
Earth Shrinkage.
Earth Classification.
Cost of Loosening and Shoveling.
Cost of Dumping, Spreading Rolling.
Cost of Wheelbarrows and Carts.
Cost by Wagons.
Cost by Buck and Drag Scrapers.
Cost by Wheel Scrapers.
Cost by the Elevating Grader.
Cost by Steam Shovels.
Cost by Cars.
How to Handle a Steam Shovel Plant.
Summary and Table of Costs.
Cost of Trenching and Pipe Laying.
The Cost of Hydraulic Excavation.
Cost of Dredging.
Miscellaneous Cost Data.
Earth and Earth Structures.
Rapid Field and Office Survey Work.
Overhaul Calculation.
A Small "Home-Made" Dipper Dredge or Steam Shovel
Detailed Description and Drawings.
Cost of Making the Dredge.
Cost of Operating.

Cloth, 5x7½ in., 260 pages, 50 figures and illustrations; $2.00 net postpaid.

The Myron C. Clark Publishing Co.
335 Dearborn St., CHICAGO

veys excels the plane table. The adjustment, the field work, the plotting of the maps and other details are described. The accuracy of this method is shown to be all that is necessary in the ordinary topographic work.

EARTH AND ROCK EXCAVATION.

Cost of Steam Shovel Excavation and Dredging at Panama. Engr. Contr., Jan. 8, 1908; 2 1-3 pp.

The cost of work on the isthmus for the past fiscal year is given in detail, showing the amount excavated per month and also for each machine, and the average per day. The number of men engaged in each detail of the work is shown, and the unit cost of the earth and rock excavation is given separately.

Cost of Digging Holes and Planting Trees and Shrubs. Engr. Contr., Jan. 1, 1908, 1 1-3 pp.

Work of this character is described and four examples of cost are given, showing each item of the work. Engineers are frequently called upon to do this class of work and should be familiar with the costs.

The Culebra Cut of the Panama Canal. By A. S. Zinn. Jl. Wn. Soc. C. E., December, 1907; 17 pp.

Gives brief history of the Panama canal and summarizes the work done and remaining to be done in excavating the Culebra cut on Oct. 1, 1907. A very good summary of the character, extent and progress of this great work of excavation.

Methods of Constructing Foundations for Lift Bridges With Some Figures of Cost. Engr. Contr., Jan. 15, 1908; ¾ p.

Describes methods employed in constructing foundations for three double-track lift bridges involving some 150,000 cu. yds. of excavation. An interesting method of driving piles in bottom of cofferdam with a driver having detachable leads is shown. Costs of excavation and of driving the piles are given.

Report of Progress on New York State Barge Canal. Eng. News, Jan. 23, 1908; 1 p.

Extracts from report of F. C. Stevens, Superintendent of Public Works, New York, referring to slow progress of work and declaring that at present rate of progress the canal would be obsolete before its completion and that nothing short of a Federal deep waterway from the Great Lakes to the Hudson River will adequately meet the needs of future transportation. Total amount of work under contract is 20 per cent. of the whole and total amount of work completed is 20 per cent. of that under contract, or 4 per cent. of whole; practically all this work was under contract prior to Jan. 1, 1907.

Statement of Col. Geo. W. Geothals, Regarding the Panama Canal Work. Eng. News, Jan. 30, 1908; 2½ pp.

Extracts from statement before Senate Committee on Interoceanic Canals, discussing change in location of Pacific locks; estimated expenditures for 1908-9; wages and salaries; contract plan vs. hired labor; cost of living in the zone; estimate of total cost of the canal and the time required for completion; difficulties of the work and other details. The statement should be read by every engineer and contractor.

High Cost for Excavation With Carts. Engr. Contr., Jan. 22, 1908; 2-3 p.

An article giving the details of the cost of such work, and showing how one item of cost by being too small increased the other items. This is an object lesson for engineers and contractors and shows the value of cost analysis.

Cost of Casting Earth for Filling in Be-

Books on Cement and Concrete

Concrete and Reinforced Concrete Construction. By Homer A. Reid.

A complete and comprehensive treatise dealing with both theory and practice. Contains working drawings of all classes of construction.

906 pages; 715 illustrations; 70 tables. Price, net $5.00

Practical Cement Testing. By W. Purves Taylor (Engineer in charge Philadelphia Municipal Testing Laboratories.

Covers a description of the properties of cement; the objects of the various tests and methods of conducting them and the practical interpretation of the results obtained.

6x9 in., 315 pp., 142 illustrations, 58 Tables. Price, net $3.00

Cement and Concrete. By Louis C. Sabin.

Treats of the manufacture, properties and testing of cement, and the preparation and use of cement, mortars and concrete, and application to practical construction.

504 pages, 161 Tables of Tests. Price net $5.00

Treatise on Concrete, Plain and Reinforced. By Frederick W. Taylor and Sanford E. Thompson.

Contains much valuable data on cement and concrete and its practical application to construction work.

6x9 in., 584 pages, 172 illustrations, many Tables. Price $5.00

Cements, Mortars and Concretes. By Myron S. Falk (Instructor in Civil Engineering in Columbia University).

A classification and summary of reliable data concerning the physical properties of cement and cement mixtures.

6x9, 184 pages, 4 Half-tones and many Illustrations. Price, net $2.50

Reinforced Concrete. By A. Considère. Translated from the French by Leon S. Moisseiff.

Tests and data on reinforced concrete.

185 pages, 20 Figures. Price, net, $2.00

Reinforced Concrete. By A. W. Buel and C. S. Hill.

A mathematical discussion and practical consideration of constructions of reinforced concrete.

6x9 in., 434 pages, 311 Illustrations. Price, net $5.00

Reinforced Concrete. By Charles F. Marsh.

A theoretical and practical discussion of concrete structures.

7¾x11 in., 530 pages, 511 Illustrations. Price, net $7.00

Experimental Researches Upon the Constitution of Hydraulic Mortars. By H. Le Chatelier. Translated by Joseph L. Mack.

A chemical and mineralogical study of cement composition.

128 pages. Price, net $2.00

Calcareous Cements. By Redgrave and Spackman.

Contains much historical matter and a description of English methods of manufacture and testing.

Second Edition, 254 pages, 63 Plates. Price, net $4.50

Concrete Steel. By W. Noble Twelvetrees.

A discussion of fundamental principles of reinforced concrete construction.

218 pages, illustrated Price, net..$1.90

Hand Book on Reinforced Concrete. For Architects, Engineers and Contractors. By F. D. Warren.

268 pages, many Tables and Diagrams. Price, net $2.50

Cement Industry. A description of Portland natural cement plants in the United States and Europe.

235 pages, 132 Illustrations. Price, net $3.00

Cements, Limes and Plasters. By Edwin C. Eckel.

A description of cement materials and processes of manufacture.

6x9 ins., 712 pages, 165 Figures, 254 Tables. Price, net $6.00

Hydraulic Cement. By Frederick P. Spalding.

The nature and testing of cement.

298 pages, 31 Figures. Price.....$2.00

Portland Cement, its Manufacture, Testing and Use. By David B. Butler.

Gives English methods and practice in manufacturing and testing.

6x9 ins., 406 pages, 97 Illustrations. Price, net $5.25

Graphical Handbook of Reinforced Concrete Design. By J. Hawkesworth.

A series of plates, showing graphically, by curves, the required design for slabs, beams and columns.

Price, net $2.50

Cost Data. By Halbert P. Gillette, Editor Engineering-Contracting.

Costs of concrete, and concrete steel structures.

4½x7 ins., 622 pages, Illustrated. Price, net $4.00

General Specifications for Foundations and Substructures of Highway and Electric Railway Bridges. By Theodore Cooper.

7x9½ ins.; 50 pages, including 18 plates. Price $1.00

THE MYRON C. CLARK PUBLISHING CO.
355 DEARBORN ST., CHICAGO, ILL.

hind Retaining Wall. Engr. Contr., Jan. 22, 1908; 1-3 p.

Itemized cost of casting earth behind a concrete retaining wall, showing a high cost of handling earth.

Hand Drilling and Plug Drilling. Engr. Contr., Jan. 22, 1908; 2-3 p.

The time element of hand drilling and plug drilling is shown, allowing a comparison of the two methods. This article shows how work can be increased by a time study. The amount of work that can be done per day can be learned, and then the men can be required to maintain a proper speed.

Cost of Wheel Scraper Work and Sloping Banks on a Railroad Job. Engr. Contr., Jan. 22, 1908; 1 p.

The cost of excavating a cut on a railroad job, showing a comparison of moving earth from the two ends, and the cost of bringing down the slopes by hand.

High Cost of Hauling Earth With Wagons. Engr. Contr., Jan. 15, 1908; 1 p.

Detailed costs are given and the result illustrates how the high cost occurred because the work was not planned properly. The fact that the excavation was made during inclement weather also increased the cost.

Comments on the Use of the Mattock. Engr. Contr., Jan. 15, 1908; 1 p.

The uses and mis-uses of the mattock are discussed at some length. The discussion is one that should be of value to contractors and engineers.

Dredging Costs on the St. Lawrence River and in Other Parts of Canada. By Emile Low. Eng. News, Jan. 30, 1908; 1 1-3 pp.

Describes extent and character of dredging work being done by the department of Marine and Fisheries of Canada, and gives costs of work itemized in percentages of the total. Cost data are of general value only as important particulars are lacking.

Cost of Excavating a Sewer Trench with a Potter Trench Machine. Eng. Contr., Jan. 29, 1908; 1 p.

Describes the method of digging a trench 10½ ft. wide and 18 ft. deep with this machine. Also the operation of the trenching machine, giving costs of the work, showing itemized costs per lineal foot of trench and also per cubic yard of excavation.

Cost of Trimming and Dressing Frozen Ground. Eng. Contr., Jan. 29, 1908; ½ p.

Comments on this class of work are made and a description of trimming and dressing up a section of a railroad bed, when the ground was frozen is given, with records of the cost of the work. The record is valuable as it shows a very high cost of dressing earthwork.

Method and Cost of Drilling Test Holes in Earth by Hand, Taking a Core. Eng. Contr., Jan. 29, 1908; ¾ p.

A description of boring test holes, and taking a core by hand, with a very ingenious machine. A record of drilling 2,454 lineal feet of holes with this tool and the cost per lineal foot, of the work, namely 40½ cts., are given. Comments are also made on the range of work of the machine.

MISCELLANEOUS.

Ball and Roller Bearings. By Samuel E. Eveland. Proc. Phila. Engrs.' Club, October; 25 pp.

An excellent descriptive paper on anti-friction bearings. Describes process of manufacturing balls and the construction of various types of bearings. States need of exactness in construction, gives results of a number of tests, specifies working levels and discusses general design and maintenance.

Suggestions for the Practical Application of Felt and Bitumen Waterproofing. Engr. Contr., Jan. 29, 1908; ¾ p.

Extracts from a paper by Edward W. De Knight before the Boston Society of Civil Engineers; gives general suggestions of methods essential to cheap and successful waterproofing with felt and bitumen.

Practical Suggestions on Computing. By Russell Tracy Crawford. Engr. Contr., Jan. 1, 1908; 2 1-3 pp.

General discussion of the best method of planning out computation work with suggestions for short cuts and labor saving methods.

Construction and Operation of Cableways With Analytical and Graphical Analyses of Stresses. By F. T. Rubidge. Engr. Contr., Jan. 8, 1908; 4 pp.

Describes the various types of cableways, their structural peculiarities, and their characteristics of operation; gives formulas used for computing deflection, stresses, etc.; presents graphical analysis of stresses in cable and towers of 953-ft. span cableway. One of the most valuable and practical articles on cableways of which we know.

Cost of Grinding Ore in Tube Mills. Engr. Contr., Jan. 15, 1908; 1-3 p.

Gives general figures of cost of grinding gold ore in tube mills; cost will run from 20 to 40 cts. per ton.

A Light Derrick. Engr. Contr., Jan. 15, 1908; 1-3 p.

Describes and illustrates a light hand power derrick easily moved and erected; derrick is particularly adapted for concrete block building work.

Obstacles to Construction Work in the Arid Regions of the West. By F. W. Whiteside.

Describes in an interesting way the obstacles in the shape of poor labor, inadequate transportation, lack of water, etc., to carrying on engineering work in the arid west.

Calculation of Mine Values. By R. B. Brinsmade. Trans. Am. Inst. M. E., January, 1908; 7 pp.

Gives a formula by which a mine can be evaluated after all pertinent physical data have been collected from observations on the ground by a competent mining engineer. Examples illustrating use of formula are presented.

New York City Fire Protection Water System. Eng. Rec., Jan. 4, 1908; 2 1-3 pp.

Describes the high pressure water system that is now practically completed to protect the dry goods district of the city, reaching from the City Hall to 25th St. Water is to be taken from the city mains or from the North or East River. Plan of the pumping station is given.

Notes on Retaining Walls. By Arthur Thomas Walmisley. The Surveyor, Jan. 3, 1908.

A general discussion of various types of retaining walls, together with notes on their construction and a graphical and mathematical discussion of their design. Short descriptions of several English retaining walls are given.

Municipal Conduit System of the City of Baltimore, Md. Elec. Wld., Jan. 4, 1908; 4 pp.

General description of the main structural features of the underground conduit system for wires being built by the city of Baltimore, Md. Drawings are given of brick manholes and concrete distribution boxes.

Car Elevator, Hudson and Manhattan Tunnel. Elec. Ry. Rev., Dec. 28, 1908; 1 p.

Describes elevator of 100,000 lbs. lifting capacity, 50 ft. long and 12 ft. wide, weighing 32,000 lbs., to be used in taking cars from the tunnel to the surface of the ground at the Hoboken terminal, for the proposed electric line under the East River. This elevator is also to be used in repairing motor trucks under the cars, and in taking out and putting in new trucks.

BENSON'S
Payroll Manual
A handy volume compiled for use in preparing pay rolls. Wages due for any number of hours from 1 to 325, at usual rates from 5 to 50 cts. an hour, shown at a glance. Saves time. Avoids errors.
Price, $2.00 postpaid.
F. T. BENSON, Port Deposit, Md.

WANTED
Engineers, Electricians
and all users of Steam and Electricity. New 25-page booklet containing the Questions asked by different Examining Boards throughout the country.
SENT FREE
GEO. A. ZELLER BOOK CO.
6 South 4th Street, ST. LOUIS, MO.

CONTRACTORS AND ENGINEERS
SAVE LABOR
Use Nash's Expeditious Measurer
A book containing 200 pages of indexed tables, which show at a glance the cubic contents of any stone or package according to its length, breadth and depth. Used by Contractors, Quarrymen and Engineers all over the world. Order of your bookseller or address the publisher. 1907 Edition Printed entirely from New Plates. $2.00 Postpaid.
A. L. NASH
17 State Street :: NEW YORK
Send for Sample Pages
SAVE TIME
AVOID ERRORS

GODFREY'S TABLES
Second Edition
This is the most useful book a structural designer could have. Price $2.50; Clubs of five at $2.
By the same Author
"CONCRETE"
will be issued in a few weeks. Over 300 pages. A book for designers and users of concrete. Price, $2.50 net.
Orders accompanied by remittance of $2, sent before March 10, will be filled as soon as the book issues from the press. After March 10, the net price will prevail.
Published by the Author
EDWARD GODFREY
Monongahela Bank Bldg. PITTSBURG, PA.

Tables of 5 Place Logarithms and 5 Place Squares
Of Feet, Inches and 32ds of Inches from 0 to 100 Feet
Also Tables of Logarithmic Secants, Natural and Logarithmic Functions, etc.
The ONLY BOOK That Gives These Values to 100 Feet
By GEO. D. INSKIP
Flexible leather, 6x7½ ins.; 278 pages; $3.00 net postpaid
THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, Chicago, Ill.

BOOK REVIEWS.

Economics of Railway Operation. By M. L. Byers, Chief Engineer Maintenance of Way, Missouri Pacific Ry. Engineering News Pub. Co., New York. Cloth; 6x9 ins.; pp. 672; $5 net.

This book is divided into seven parts, as follows: (1) Organization; (2) Employment, Education and Discipline of Forces; (3) Accounts and Accounting; (4) Reports; (5) Economic Operation; (6) Analysis of Operations and Control of Expenses; (7) Betterments. By all odds the best of these "parts" is the one on Economic Operation, which is divided into six chapters and covers 350 pages. As for the other parts, it would have been better, perhaps, had they been called appendices. The author had an ambitious scheme in endeavoring to cover the whole field of railway operation, but his lack of familiarity with many departments has prevented him from carrying out his entire plan with great success. For example, his "part" on Accounts and Accounting is little more than a reprint of a set of rules for accountants to follow, such as are obtainable in printed form from any large railway. Had the author printed these rules with a discussion, however brief, of railway accounting principles and illustrative details, he would have performed a much more valuable service.

The part on Economic Operation contains the following chapters: General (1p.); Maintenance of Way and Structures (82 p.); Machinery Department Operation (87 p.); Transportation (69 p.); Freight and Traffic Department (7 p.). Other Departments (13 p.). From the number of pages allotted to each chapter it is evident which ones receive most adequate treatment. The chapter on Maintenance of Way and Structures is excellent, brief though it is. The chapter on Machinery Department Operations is only slightly less meritorious. But the other chapters are far below these in merit, and this is particularly disappointing in view of the title of the book. The chapters on Transportation and on Freight Traffic Department, which should have been the great chapters of the book, since "conducting transportation" amounts to about 57% of the total operating expense of the average American railway, are weak chapters.

This book will be found to be of greatest value, not because of its analyses of the problems of railway operation—other than maintenance of way—but because of its character as a reference book of forms, rules, and other printed matter that every large railway issues for the guidance of employees. This, in itself, is sufficient to give the book a large sale and an extended use by civil engineers engaged in railway work, as well as by men in the various departments of a railway. The civil engineer will be particularly benefited by this book, not only because it is written by a civil engineer, but because it gives him some insight into the system of accounting and reporting used in the various departments.

Electric Railways. A Series of Papers and Discussions Presented at the International Electrical Congress in St. Louis in 1904. McGraw Pub. Co., New York. Cloth, 6x9 ins.; pp. 447; illustrated; $3 net.

Though electrical and railway engineers have been long familiar with the 20 papers which make up this volume many of them will welcome the opportunity to have them all collected, with the gist of the discussions which followed their reading, in one place, and in uniform style. It is unnecessary here to itemize these papers. They all relate to electric railway problems and practice of one kind or another and they have been written by the American and foreign engineers whose names and achievements stand highest in the field of electric railway work. Electric railway development is moving ahead so fast that a paper on practice even as recent as 1904 is in one sense out of date, but the principles of development remain much the same now as then, and in these regards the papers by Arnold, Dawson, Steinmetz, and other authorities are still timely and prophetic of the future. The volume is one which the electrical engineer should have in his library.

Specifications and Contracts. By J. A. L. Waddell and John C. Wait. Engineering News Pub. Co., New York. Cloth, 6x9 ins.; pp. 169; $1.

This book may be said to be made up of five parts: First, a discussion of specifications; second, examples for practice in specification writing; third, a discussion of engineering contracts; fourth, examples for practice in contract writing, and fifth, notes on the law of contracts. The first four parts are written by Dr. Waddell and the fifth part by Mr. Wait.

Originally, Dr. Waddell gave the subject matter of this book as lectures to engineering students. Based on his own experience, his lectures were talks showing some pitfalls into which the engineer falls in writing specifications and contracts. He gives a great deal of exceedingly valuable advice in writing various kinds of specifications and contracts, and the clauses that are embodied in them. Although the lectures were meant primarily for students, still all engineers can profit from the suggestions. The book could well be used as a reference guide by engineers when writing specifications and contracts.

Mr. Wait deals entirely with contract law, and covers the subject in as satisfactory a manner as is possible in the comparatively small space allotted, namely, 38 pages.

Plane Surveying. By Alfred E. Phillips, Professor of Civil Engineering, Armour Institute of Technology. American Correspondence Schools, Chicago. Cloth 6½x9¼ ins.; pp. 200; 133 illustrations; $1.50.

The subject of plane surveying lends itself particularly well to treatment in a book designed for self instruction and the author has done generally good work in this volume. Roughly the text may be divided into (1) Measurement of lines; (2) Leveling Instruments and leveling, and (3) Land and Topographical Surveying. The treatment follows the usual lines beginning with simple methods of measuring lines and areas, proceeding to the simple and then the more complex leveling operations and then taking up about in the order of their growing difficulty the problems of land surveying with the compass, exact surveying and traversing with the transit, stadia work, the use of the gradienter, the adjustment and use of the polar telescope, etc. Public land surveying methods, topographic methods, base line measurement and triangulation are also briefly treated. The various instruments are described and their operation and adjustment explained. The book is a worthy treatise on the elements of plane surveying.

How to Burn Illinois Coal Without Smoke. By L. P. Breckenridge. University of Illinois Engineering Experiment Station, Urbana, Ill. Paper 6x9 ins.; pp. 44; illustrated.

The purpose of the author in this pamphlet is first to lay down the principles of smokeless combustion and second to illustrate by furnaces in actual operation several ways in which these principles have been satisfactority applied. It has evidently been kept in mind that the person who needs instruction most is the boiler user and the city official who is not a mechanical engineer. The various principles and descriptions are written in language plain to everyone. The principles of smokeless combustion are first explained and then the author describes how by not applying these principles smoke is produced. Losses due to smoky chimneys are explained, then follow descriptions of the well known Ringelmann and other methods of grading the density of smoke. The pamphlet next gives results of tests of several types and styles of furnaces for smokeless combustion of various Illinois coals. Drawings of the different boiler settings and furnace arrangements are shown. There are special discussions of smoke prevention with horizontal fire tube boilers; of how to hand fire Illinois coal so as to reduce the production of smoke, and of how to prepare coal for smokeless burning. The pamphlet is a practical demonstration of the possibilities of smokeless combustion which will prove highly useful.

The Steam Engine. By Walter B. Snow and Walter S. Leland. American Correspondence Schools, Chicago. Cloth 6½x9¼ ins.; pp. 156; illustrated; $1.

This volume is one of the series of self-instruction books published by the American Correspondence Schools primarily for the use of its pupils. It is divided into four parts or sections: (1) Details of Construction and Types of Engines; (2) Engine-Room Accessories and Engine Operation; (3) Thermodynamics of the Steam Engine and (4) The Steam Turbine. The treatment is necessarily brief and is of course elementary. For the class of readers for which it is intended it will provide a fair general knowledge of steam engine construction and operation, and of the broad principles on which these are based. The book is not one for the trained engineer or expert.

Diagrams of Electrical Connections. By Cecil P. Poole, M. Am. Inst. E. E. McGraw Publishing Co., New York. Cloth 6x9 ins; 113 pp.; 130 illustrations; $2 net.

In his preface the author says: "Recognizing the impracticability of making a book of this kind exhaustive, especially with regard to switchboard diagrams, the author has restricted the scope of his efforts to fundamental systematic diagrams for all practical machines and devices and diagrams of actual connections of the principle types of apparatus in general use." Text, generally brief, defines the character and explains the purpose of such connection which is also illustrated by a diagram. There are in round numbers some 130 of these explanations and diagrams grouped under the following headings: rheostats, generators, motor starters and controllers, railway motor controllers and wiring, switchboards, transformers, converters, light and power distribution, railway track and station equipment, generator and circuit regulators and instruments. The book is well printed and bound and the illustrations are generally good.

Manual of Recommended Practice. American Railway Engineering & Maintenance of Way Association. Chicago, Ill. Cloth 6x9 ins.; pp. 291; illustrated; $3.50.

This new edition of the manual contains all definitions, specifications and principles of practice adopted by the Association. There are two complete indices, the one in the front of the book giving the contents by subjects while the index in the back of the book is arranged alphabetically. The following are the principal subjects treated: Roadway, Ballasting, Ties, Rail, Track, Buildings, Wooden Bridges and Trestles, Masonry, Signs, Fences, Crossings and Cattle Guards, Signaling and Interlocking Records, Reports and Accounts, Water Service, Yards and Terminals, Iron and Steel Structures, Classification of Tracks, Uniform Rules, Organization, Code, etc.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance) – ***$2.00*** *a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*

$2.50 *a year (52 issues) to Dominion of Canada.*

$3.00 *a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Entered as second-class matter April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

The Ashokan Reservoir Controversy as a Contest Between the Advocates of Cost Analysis and Their Opponents 95

CONCRETE SECTION:

A Metal Lagging for Concrete Forms and Arch Centers 96
Method of Underpinning an Engine Foundation 97
Method and Cost of Constructing a Reinforced Concrete Culvert 97
Concrete Pipe Protection of Piles from Teredo 98

EARTH AND ROCK SECTION:

The Estimated Cost of the Ashokan Reservoir and Data of Actual Cost of Similar Earth Embankments, Together with a Discussion of the Testimony Submitted in the Investigation of the Ashokan Dam Award ... 99
The Cost of Doing Scraper Work in Freezing Weather 102
The Cost of Digging a 36-Mile Trench with a Traction Ditcher 103

GENERAL ARTICLES:

Formulas for Estimating the Quantities of Materials in Timber and Pile Trestles and Hints on Estimating Costs 104
METHODS AND COSTS 105

The Ashokan Reservoir Controversy as a Contest Between the Advocates of Cost Analysis and Their Opponents.

A generation ago there was but one method in common use among engineers for estimating the probable cost of an engineering project, namely, the application of contract prices—"going prices." A civil engineer regarded cost analysis and cost synthesis as being matters for the consideration of the contractor, perhaps, but not for the designing engineer. Gradually, however, this idea has been losing ground, and many engineers now hold that it is quite as important for a civil engineer to be able to analyze costs as it is for a contractor. There have been many skirmishes between the advocates of the old idea and the advocates of the new, but the first battle of great importance was brought about by the rejection of the ten million dollar John Pierce Co. bid for the Ashokan Reservoir on the ground that it was "below actual cost." The engineers who recommended this rejection were finally called upon to defend their position, and, in making their defense, it developed that they were unanimous in their opinion that cost analysis should not, or could not, be used as a safe guide. They stoutly maintained that it was much better to draw from their general experience, size up the situation, and make a "scientific guess" at the probable unit cost, or rather at the probable contract price which would yield a fair profit. There were four engineers who took this position, namely: J. Waldo Smith, Chief Engineer of the Board of Water Supply of New York City; Frederick P. Stearns, John R. Freeman, and Prof. William H. Burr, Consulting Engineers of the Board.

A Board of Advisory Engineers, selected by the Commissioners of Accounts, took a radically different stand. This Advisory Board consisted of Otto H. Klein, Chief Engineer of the Commissioners of Accounts; Col. Thos. W. Symons, Halbert P. Gillette and Daniel J. Hauer. They made an analysis of the actual cost of the Ashokan Reservoir, upon which they based their report that the bid of John Pierce Co. would have yielded a fair profit. Subsequently the Corporation Counsel selected five consulting engineers, Major Cassius E. Gillette, A. P. Davis, Edward Wegmann, R. W. Creuzbaur and Chauncey Ives, to investigate the matter further. These engineers confirmed the position taken by the Board of Advisory Engineers, to the effect that the bid of John Pierce Co. would have yielded a fair profit.

Aside from the facts in the matter, it is of special interest to note that not one of the five consulting engineers just mentioned, and not one of the four engineers on the Board of Advisory Engineers, took the position that the actual unit cost of the work at Ashokan could be estimated accurately except by a process of cost analysis and cost synthesis. Here are nine engineers taking one position in direct opposition to four engineers taking another position. Who is right? This journal stands committed to the cost analysis method of estimating. Indeed it seems to us almost self-evident that no man can estimate the unit cost of engineering work accurately without breaking it up into its elements. Conditions vary so greatly on different structures that no two unit costs are the same. Hence, in order to make proper allowance for each varying condition, it is necessary to analyze the cost into its elements. In the case of steam shovel excavation, for example, the variable may be price of common labor, while the wages of engineers, cranesmen, etc., may be practically constant for years. The length of haul may vary, while all other elements remain unchanged. How any engineer can seriously defend an estimate of "actual cost" that is not arrived at by a process of analysis is beyond our comprehension. Yet, here are four engineers, eminent in the profession, who defend an estimate based on "general experience." To us their position seems analagous to that assumed by a rule of thumb carpenter who scouts the idea that a technically trained engineer can design a roof truss better than he. The carpenter may be right, in some particular case, but his general position is wholly illogical. He claims to be able to draw from his long experience, by intuition as it were, an economic design for a roof truss, and, where conditions are precisely the same as those previously encountered, he may do tolerably well. But even the youngest civil engineer is infinitely his superior as a designer of roof trusses, where the conditions are different from those previously encountered by the carpenter, for the engineer resorts to an analysis and not to a guess.

Now, on work such as the building of these great earthen dams at Ashokan, not one of the four engineers of the Board of Water Supply could produce a comparable example drawn from his own experience. Mr. Stearns had been in charge of dikes at Wachusett, but they were all low affairs and built almost entirely without the use of steam shovels, because the earth was merely a soil stripping best loaded with pick and shovel. His other experiences with earth reservoirs were of a similar nature, with one or two small exceptions where a steam shovel was used unprofitably, either because of the shallowness of the cut or because of the nests of huge boulders encountered. And in no case had he kept any records of actual cost to the contractor. Mr. Smith had also built several small earth reservoirs, but without the use of steam shovels, and had kept no detailed estimates of actual cost. The other two engineers were less experienced than either Mr. Smith or Mr. Stearns, and their records of actual costs were even more meager.

Since none of them could draw from his experience an example of earthwork comparable even in its general aspects to the work at Ashokan, how, in the name of common sense, could any of them hope to be able to estimate its probable unit cost with accuracy? But, had these engineers kept detailed records of the work that they had been connected with, none of them would have been likely to shoot so far of the mark; for, then, at least some of their details would have been applicable, and, by a combination of all of them, a tolerably close estimate might have been made.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

A Metal Lagging for Concrete Forms and Arch Centers.

The metal lagging shown by the accompanying sketches has been successfully used in very important concrete sewer work and is applicable to forms for concrete walls, floors and other structures.

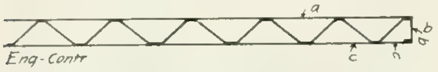


Fig. 1. Section of Metal Lagging.

Figure 1 is a cross-section of a sheet of this new lagging. It consists, as will be seen, of two plain sheets, *a* and *c*, of metal rigidly attached to an intermediate corrugated metal sheet *b*. The thickness *a* to *c* varies from ½ in. to 3 ins. according to requirements, the gage of the steel running from No. 24 to No. 16. Flat sections weighing under 4 lbs. per sq. ft. develop about twice the resistance of 2-in. yellow pine plank to binding.

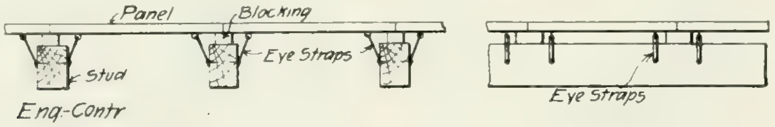


Fig. 2. Sketch Showing Manner of Using Metal Lagging for Wall Forms.

The method of using this lagging for wall forms is shown by the sketch, Fig. 2. Eye-straps *a a* are fastened to the corners of the panels of lagging and are attached to the studding as shown. Where it is desired to remove the lagging without disturbing the studding the blocking *b b* are used, otherwise the lagging bears directly against the studding.

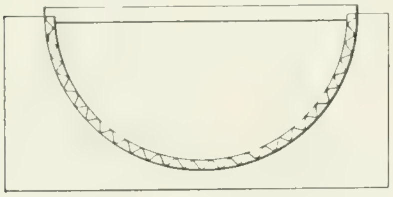


Fig. 3. Metal Lagging Used as Invert Form for Sewer.

Figures 3, 4 and 5 show the application of the lagging in sewer construction or other conduit work. Fig. 3 shows the arrangement for invert work. Fig. 4 shows a center used by the Jenks-Anderson Co., Brooklyn, N. Y., in constructing the Morgan Avenue sewers in Brooklyn, N. Y. These sewers had brick inverts and the form was designed for this condition. Fig. 5 shows the form for a 13½-ft. concrete sewer built to receive later a 4-in. brick invert lining. In constructing this lagging for arch forms the outside steel sheet away from the concrete is replaced by narrow strips or bands which are bolted to the flat outside parts of the corrugated sheet. It is obvious that the spacing of the bolt holes in the bands determines the radius of the panel, and to vary the curvature of any panel, producing compound curvature if desired, it is only necessary to use suitable drilling in the bands.

One of the best adaptions of this form is in molds for sewers, conduits, etc., where it may be entirely self-supporting and does not require any inside bracing or studding. This obviates the adjustment of any moving parts in collapsing and moving forward and leaves almost the entire cross-section of the bore clear for the workmen

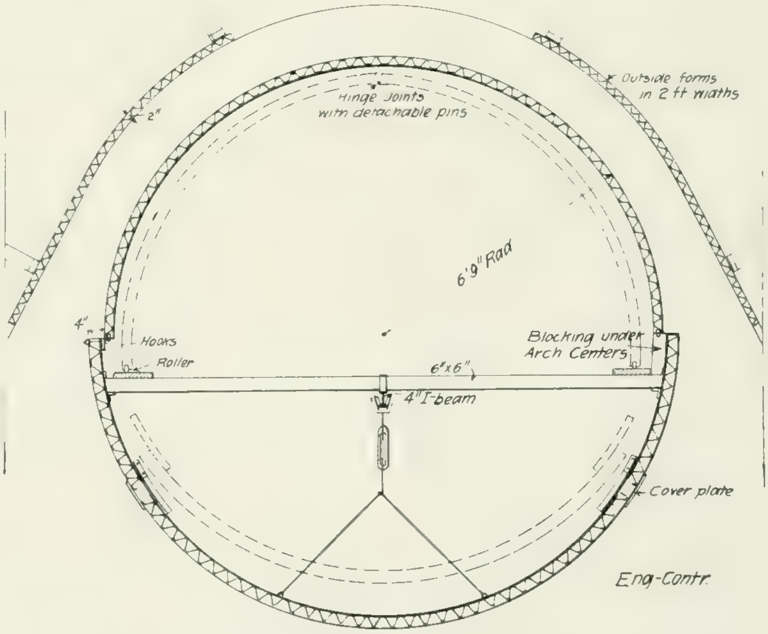

Outside forms in 2 ft widths
Hinge Joints with detachable pins
2"
6'9" Rad
4"
Hooks
Roller
Blocking under Arch Centers
6"x6"
4" I-beam
Cover plate
Eng-Contr

Fig. 5. Method of Using Metal Lagging for Form for 13½ ft. Sewer.

or for the operation of material cars in tunnel work. It has the added advantage that rear sections of the centering on which the masonry has taken its set can be collapsed, drawn through the forward sections where the masonry is being laid, and set up in advance. This feature effects an economy of some 20 per cent to 40 per cent in the total feet of centering required on continuous work. It also makes possible, where desired, absolute monolithic construction without vertical or horizontal joints.

This lagging is the invention of Mr. Keith O. Guthrie, Assoc. M. Am. Soc. C. E., and is patented; it is manufactured and leased or sold under the trade name of "Duralite" by the Duralite Co., 42 Broadway, New York, N. Y.

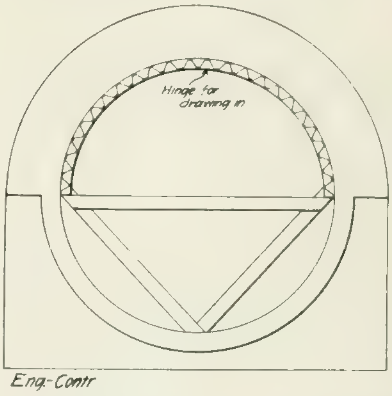
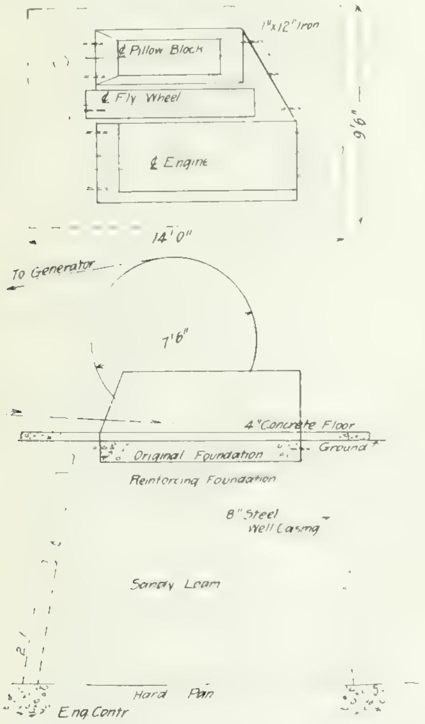


Fig. 4. Method of Using Metal Lagging for Sewer Center.

The Imperial Maritime Customs of China has specified that the paint manufactured by the Teredo-Proof Paint Co., of New York, be used on the wood work of two new warehouses to be built in China by that department. The paint is to be used simply as a protection against the white ant, the decision to do this having been reached after tests which showed that in no case did the white ant attack wood that had been protected with this paint.

Method of Underpinning an Engine Foundation.

The accompanying sketch shows the method adopted for underpinning an engine foundation at the factory of the Pacific Coast Condensed Milk Co., at Mt. Vernon, Wash. The factory is located on the banks of the Skagit river. The soil is a very loose sandy loam, and when the factory was built the concrete foundation for the 125 HP. Corliss engine was placed on this loam as shown by the sketch. Under the motion of the engine the foundation soon began to rock in the direction in which the engine was running, the range of its movement being from ½ to 1 in. Soon the foundation broke away from the concrete floor and its movements grew more violent until the bed plate of the engine was finally broken. It became necessary to strengthen the foundation.



Sketch Showing Method of Underpinning Concrete Engine Foundation.

As the engine was installed in a brick engine house of very substantial construction, it would have been very expensive to remove a portion of the wall so that a pile driver could be taken inside and piles driven to reinforce the foundation. At the suggestion of the Pacific Engineering Co., Seattle, Wash., the plan was adopted of sarrounding the old foundation with a concrete footing carried on piers or piles formed by sinking 8-in. well casing and filling it with concrete. Six of these piles were sunk as shown by the sketch. The original foundation was first excavated around as shown and a hole 6 ft. deep was dug where each pile was to go. The 8-in. well casing was then set in the hole and jetted down, using a 1½-in. pipe 18 ft. long and water supplied at 60 lbs. pressure by a pump. The casings went down without trouble and were settled on the hardpan by means of a lever attached to the bottom of the original foundation by means of a chain and hook. When firmly settled into the hardpan the casings were excavated around the bottoms by means of a sand pipe with a cutting edge, a cavity about 2 ft. wide and deep being thus made. The cavities and casings were then filled with 1—2½—4 concrete. About ½ cu. yd. of concrete went below the casing in each case giving a very firm footing.

The next step was to place the new concrete footing. First 1-in. holes 6 ins. deep were drilled into the sides of the original foundation near the bottom and 1 x 12-in. bars were inserted in these holes to bond the original foundation to the new footing. The footing was made of 1—2½—4 concrete and was allowed to set 24 days when the repaired engine was replaced and run with full load at full speed before the 8-in. concrete floor was placed around the foundation. No movement was perceptible and none has occurred during the year the engine has been running.

We are indebted for the information from which this article has been prepared to Mr. Guy Boschte Engineer of Construction, Pacific Engineering Co.

Method and Cost of Constructing a Reinforced Concrete Culvert.

The culvert was constructed in Jasper county, Mo., and cost $743.70 complete. The arch, as shown by the accompanying cut, is parabolic, 16½ ft. in span and 6 ft. in height from spring line to curve and 3 ft. from spring line to water line; it gives a water way 9 x 16½ ft. The arch ring is 15 ins. thick at the crown and 3½ ft. thick at the spring line and is reinforced by two sets of rods curved to the arc of the arch and set 3 ins. from extrados and intrados, respectively. These arch rods are spaced 12 ins. on centers and each set is tied across by transverse rods also spaced 12 ins. in centers. The spandrel walls are 12 ins. thick and are reinforced by vertical rods. All reinforcement was ¾-in. Johnson corrugated bars. The culvert is 32 ft. long with a 20-ft. roadway.

The concrete arch was composed of Iola Portland cement and chats or tailings from the Missouri lead and zinc mines. These tailings are crushed to the size of a large bean or chestnut and are free from all mineral substance. They can be had in any quantity for the cost of hauling. The chats contain more or less sand so that the concrete was proportioned 2—2—6 and mixed rather wet. The amount of concrete in the culvert was 91 cu. yds.

Wages and materials cost as follows: Teams $3.50, foreman $4, carpenter $3 and laborers $1.75 per day. Tailings cost 80 cts. per cu. yd. for hauling; sand cost 10 cts. and 80 cts. per load for hauling or total 90 cts. per load of 1½ cu. yds., or 60 cts. per cu. yd. Corrugated bars cost $88 and $26 for freight or $114. Lumber for centers and forms cost $62. Cement cost $2 per bbl. The cost of the work was:

Item.	Total.	Per cu. yd.
Cement	$ 96	$1.05
Chats and sand	35	0.38
Reinforcement	114	1.25
Lumber	62	0.68
Labor	498	5.47
Total	$805	$8.83

In further explanation of these costs it should be noted that the labor includes excavation of foundations 5 ft. to bed rock, sheeting the pits and bailing. The lumber was largely salvaged and is to be used on several other culverts of the same size so that only a portion of the total is properly to be charged to this job. This culvert was built by day labor under the direction of Mr. Wm. Kohlman, County Surveyor and Bridge Commissioner, Jasper county, Carthage, Mo.

Concrete Highway Culvert of 16½ ft. Span.

Concrete Pipe Protection of Piles From Teredo, Charlotte Harbor & Northern Ry.

The right of way of the Charlotte Harbor & Northern Ry., at present operating between Arcadia, Fla., and Boca Grande, at the south end of Gasparilla Island, at the entrance of Charlotte Harbor, a distance of 62 miles, and under construction between Arcadia and Plant City, a distance of 60 miles, crosses considerable stretches of salt water. The main structures on that portion of the line now in operation are the Gasparilla Sound bridge, which is two miles long, and crosses from the mainland to the island; Myakka River bridge, one-half mile in length, and Coral Creek bridge, a quarter of a mile in length. These bridges are all pile trestle structures and being located in waters infested by the teredo required protection for the piles below water. The accompanying views show the style of protection adopted.

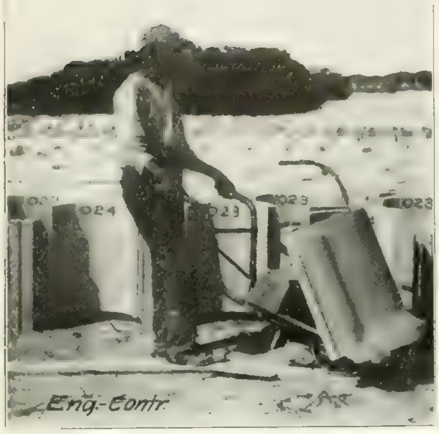


Fig. 1. View Showing Sections of Molded Pipe.

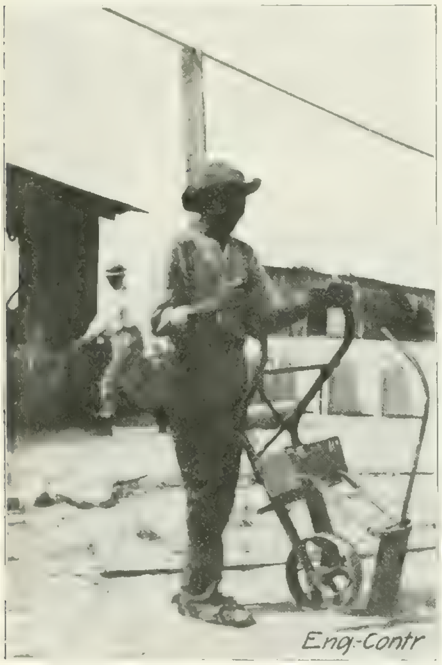


Fig. 2. View Showing Special Barrow for Handling Pipes.

Each pile from a point above high water to a point below the sand bottom was encased in concrete in the form of sections of pipe filled in with sand. The pipes used are of concrete made in two sections which are locked together by a wooden key. This pipe is known as lock joint pipe and is made and placed by the Lock Joint Pipe Co., New York, N. Y. In shape this pipe resembles somewhat ordinary vitrified sewer pipe, it having bell and spigot ends, but each pipe instead of being made in one piece is split longitudinally, or more correctly, is molded in two pieces the edges of which engage each other and are locked together by inserting a narrow wooden key into a suitable groove or keyway. An idea of the shape of a half-section of pipe is given by Fig. 1. These half-sections are molded in metal molds and allowed to set hard before placing. Fig. 2 shows the special barrows used for handling the molded sections.

The pipe is molded to a diameter somewhat larger than that of the pile to be protected, so that an annular space is left between pipe and pile. This annular space is filled with sand, which serves the double purpose of cushioning the pipe against the pile and of providing a loose joint which permits the pipe covering to slide down and keep the pile covered in case the bottom is lowered by scour. The pipe being molded in two pieces can be applied to the piles of existing structures as shown by Fig. 3. Any one-piece pipe can, of course, be applied to piles only before they have been capped. In the work for the structures mentioned above, the pipe covering was done from a barge which was pulled along the trestle as the work progressed. A record for 3,350 piles protected for a length of 12 ft. each, was 26 piles or 312 lin. ft. of pile protected each day. The pipe was molded on shore and taken to the barge by tugs.

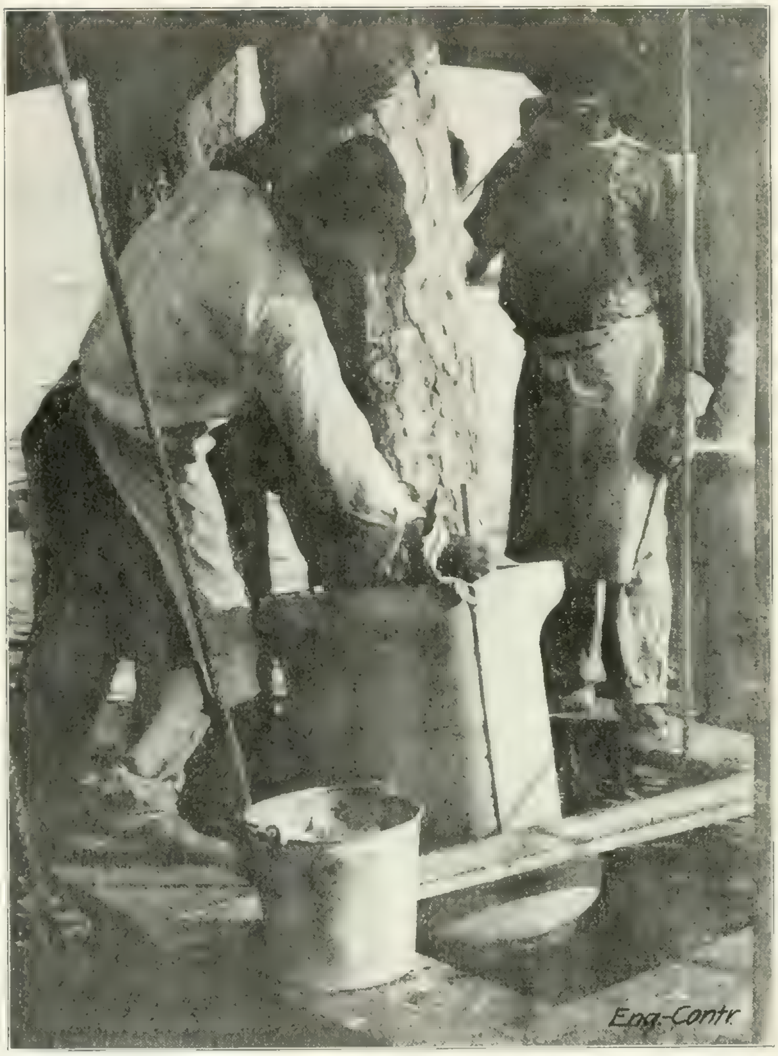


Fig. 3. View Showing Method of Applying Pipe to Piles.

The city of Tokyo, Japan, on March 31, will take over the local electric railway, the price paid being $38,750,000 gold.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Estimated Cost of the Ashokan Reservoir and Data of Actual Cost of Similar Earth Embankments, Together with a Discussion of the Testimony Submitted in the Investigation of the Ashokan Dam Award.

Neither in engineering journals nor in the daily press has there appeared more than a one-sided summary of the facts relating to what has been termed "The Ashokan Dam Controversy." It is our purpose to give the facts in some detail, not only because of the principles at stake but because of the general usefulness of the cost data presented by the various engineers.

As for the principles involved, there are two: First, the public policy of awarding a contract to other than the lowest responsible bidder. Second, the applicability of contract prices and engineering guesses in estimating work of magnitude.

It is perhaps not over stating the case when we say that no similar controversy has been more rich in data as to the costs and as to methods of estimating costs.

The city of New York is about to spend $160,000,000 for a water supply system, and one of the first large contracts awarded is the contract for the Ashokan Dam or Reservoir in the Catskill mountains. This contract was awarded to MacArthur Bros. Co. and Winston & Co. for $12,669,775, which is about $2,300,000 in excess of a bid made by the John Pierce Co. The Board of Water Supply, who made the award, was guided in its action by the advice of its chief engineer, Mr. J. Waldo Smith, and by three consulting engineers, Frederick P. Stearns, John R. Freeman, and Prof. William H. Burr. These engineers were unanimous in stating that the bid of John Pierce Co. was below "actual cost," and that it would, therefore, be unwise to award the contract to the lowest bidder.

Vigorous protests against this action were made, and the mayor directed the Commissioners of Accounts to investigate the matter. Accordingly a board of advisory engineers was appointed, and, upon receiving their report, a hearing took place before the Commissioners of Accounts, at which hearing the Board of Water Supply and their engineers were given an opportunity to set forth the reasons for their action. The Board of Water Supply dodged the issue by saying that they had followed the advice of their engineers, and produced written reports from their chief engineer and the three consulting engineers. In his report, the chief engineer, Mr. J. Waldo Smith, said: "The bid of the John Pierce Co. is so low that I believe from long experience and my knowledge of the conditions which must be met that the work cannot be done at the prices they have named. Their prices for the earth excavation and embankment items are such that they are much below the actual cost of doing this class of work."

When first questioned during the hearing as to the facts that led to this opinion, Mr. Smith made general statements only; and, when finally asked to analyze the probable cost of the earthwork at Ashokan, Mr. Smith replied:

"Well, I did not make my estimate that way. I did not go into the analysis of any one of those items. I want to make that clear right now, because it may save us some trouble later on; it was made up from my knowledge of what similar work has cost, of which I have known the conditions.

"I never analyze cost; I never do it in that form; I do not believe that is the proper way to make an estimate; I think it only leads to confusion to try to analyze it, and erroneous conclusions."

On the other hand, the Board of Advisory Engineers to the Commissioners of Accounts in their report had stated:

"We wish it clearly understood that our opinion of the reasonableness of the John Pierce Co. bid rests not upon contract prices but upon an analysis of the cost of this work under the actual conditions existing at the Ashokan Reservoir."

Commissioner of Accounts John P. Mitchel, in a conference with his nine consulting engineers, said:

"The question arises, whether cost analyses are necessary to obtain a reliable estimate of the cost of doing work, and whether the estimate of cost upon which a bid is to be rejected or accepted can be made except through the process of cost analysis."

Each of the nine, in answering whether this was a fact or not, stated emphatically that cost analysis is the only practical method to use.

Major Cassius E. Gillette said:

"Practically, in my judgment, there is absolutely no way of making a reliable estimate of the cost of doing a particular work except by cutting it up into its ultimate elements, and making estimates of each in turn, based upon a number of other cost analyses of work that come near coinciding in those particular elements. Any one who says he can make an estimate by any other method, if tested in a particular case, will find himself letting go of his general estimate and getting into a detailed analysis of the various elements to an astonishing degree, every time."

Mr. A. P. Davis, chief engineer of the Reclamation Service, said: "It requires a much higher degree of skill to use cost analysis than to guess. You may happen to know a certain thing because you have seen that particular bid. It requires no knowledge or skill to do that; but, to apply cost analysis, judgment has to be applied to every item, and it is very unsafe for an unskilled person to use cost analysis. I am going to make one more point. While we (meaning the Reclamation Service—Eds.) have not had occasion to reject bids because they were too low, we have had frequently occasion to do so because they were too high, and we require some cost analysis; and the executive officers are exceedingly careful, and we have to explain our estimates as to their being below the lowest bid, in order to get authority to reject the lowest bid as being too high."

Similar opinions were expressed by the other consulting engineers to the Commissioners of Accounts.

It is also a significant fact that the bid of the John Pierce Co. made by their engineer, Mr. Ernest C. Moore, was based on an analysis of the cost in detail of every item of work that was to enter into the construction of the Ashokan Dam. Mr. Moore submitted a copy of this analized estimate to the Commissioners of Accounts, at the hearing. It was testified to at the investigation that the bid of the next lowest bidder was not made up by an analysis of the cost.

So far as methods of estimating costs were concerned, the issue was clearly joined. On the one side were the engineers of the Board of Water Supply, claiming that an accurate estimate of actual cost could be made without any detailed analysis. On the other side were the advisory engineers of the Commissioners of Accounts, with equal positiveness claiming that no accurate estimate of actual cost of such work as the Ashokan Dam could be made except by a process of analysis; for, with varying conditions as to toughness of earth, length of haul, rates of wages, price of coal, kind of plant, etc., it was claimed that other contract prices and other lump sum unit costs formed no reliable precedent.

In the course of the hearing a cross-examination of each of the engineers of the Board of Water Supply was conducted for the purpose of ascertaining what real basis they had for assuming that the John Pierce Co. bid was below "actual cost," and this cross-examination disclosed the following facts: First, that the chief engineer, Mr. Smith, had never kept any detailed records of the actual cost of steam shovel work, anywhere, although he conceded that the embankments at Ashokan would be built with steam shovels. He had been in charge of several small reservoir dikes, but, in every case, the work had been done with picks and shovels, scrapers or elevating graders. Even in those cases he had kept no detailed records of the unit costs, but had kept unit costs in the aggregate only.

Second, that the three consulting engineers, Stearns, Freeman and Burr, had even more meager data of actual cost of earthwork. Mr. Stearns had been the chief engineer in charge of the Wachusetts reservoir dikes, but had no detailed records of actual cost to the contractor. Moreover, those dikes were all low and built of material loaded by hand. He had had other experiences on small reservoir embankments, and, in one or two instances, steam shovels had been used but not satisfactorily. In one case the shovel had encountered nests of huge boulders. In another case the cutting was too shallow for profitable shovel work.

Mr. Freeman frankly stated that he relied on "going prices," and had very little knowledge of actual costs.

Prof. Burr said he had made an analysis of the probable cost of the earthwork at Ashokan, and promised to produce it, but subsequently refused to place his analysis on record. He had made the analysis merely as a rough guide to his judgment, and did not care to produce it. He had had little experience in reservoir construction, other than as a consulting engineer on certain projects, and produced no detailed records of actual cost.

Three subordinate engineers had made estimates of the cost of the Ashokan Reservoir, as a check on the estimate of Mr. Smith; but none of these three produced any detailed records of actual cost of rolled earth embankments built with steam shovel that had come under his own observation.

The reader should bear in mind that the rejection of the John Pierce Co. bid hinged upon his price for earth embankments, and that these earth embankments, involved the excavation of some 7,000,000 cu. yds., which everyone conceded must be done by steam shovels. Indeed, the very blue prints of the work showed how many cubic yards would have to be placed each year, and how many steam shovels would be required.

Confessedly opposed to cost analysis and ignorant of detailed costs, they had left only one line of real defense, namely a citation of contract prices. Mr. Stearns was particularly prolific of these.

The distinction between a contract price and a contract cost must be borne well in mind. A contract price is often too low to yield a profit, and occasionally so high as to be an extortion. It means next to nothing unless applied to work identical in every respect with previous work that has been done at a fair profit under that price. And, of all classes of contract work, none is more variable than earthwork in its cost. There is no such thing as a "going price" for earthwork.

Mr. Stearns named several contract prices for reservoir embankments, all very much lower than the prices bid for the Ashokan work, and, in order to reduce them to an 8-hour day basis and to rates of wages now prevalent, he added certain percentages. He was careful to select only the highest prices and omitted many that were low. His method of conversion consisted in dividing the present hourly rate of common labor wage by the similar hourly rate existing on work done at other places, and thus securing a factor or percentage to be used in converting contract prices. But such a conversion on the basis of the wages of common laborers is fallacious. For example, common labor has risen in price, whereas steam shovel engineers and other skilled men receive to-day about the same as they have received for many years past. Common laborers often do not make up half the payroll on a steam shovel job, beside which the fuel and supplies form a very large percentage of cost that remains wholly unaffected by changes in rates of wages of common laborers. It will be seen that Mr. Stearns was forced into a sort of cost analysis, even when using contract prices.

We come now to the report of the Board of Advisory Engineers to the Commissioners of Accounts. This board was composed of four members: Otto H. Klein, Col. T. W. Symons, Halbert P. Gillette and Daniel J. Hauer.

After making a close study of the work on the ground, and also of the plans and specifications, they found that one fact stood out pre-eminently in regard to the prices bid. Section 100 of the specifications stated that all "acceptable material from the channels and other excavations" shall be used in embankments and refills. Sections 66 states that "such materials as are suitable and permitted may be used in the construction, and if so used shall be paid for according to the class of work in which they are used, in addition to the price paid for excavation." Section 81 confirms this statement. It is clear, therefore, that all acceptable earth taken from excavation is to be paid for twice—once when measured in excavation and again when measured in embankment.

In the estimated quantities of work to be done there are about 2,000,000 cu. yds. of excavation and about 7,000.000 cu. yds of all classes of embankment. The average price bid by John Pierce Co. for the embankment is 39 cts. As nearly the entire 2,000,000 cu. yds. of excavation is either directly on the site of the dikes, or in a channel adjacent to them, and, as the material from the test pits and borings shows that it is acceptable, it is evident that the contractor will use this excavated material for the dikes. In fact it is the logical plan of deposit for the excavated material, as the haul is no longer than from the borrow pits. The engineer of the Pierce Co. testified that it was his intention to borrow large quantities of the material for the dikes from along the channel to be excavated, by widening the channel cut. Taking this second payment into consideration, and allowing for shrinkage, the price of the Pierce Co. for embankment is increased by 7¼ cts. per cu. yd., making the total price about 46 cts. per cu. yd. of embankment.

The Advisory Board of Engineers deemed this price sufficient to yield a handsome profit on the earthwork.

They cited in their report that to obtain records of reservoir work that were comparable to Ashokan, one must look to the large earthen dams in the West. In taking into consideration these Western dams, it must be remembered that wages are much higher in the West than in the East; team feed costs more, coal and other supplies are much higher; and the local conditions in the West all have a tendency to increase the cost of work in the West over that done in the East.

One of the best known of the Western dams is the Tabeand Dam, regarding which the Advisory Board of Engineers said:

THE TABEAND DAM.

"The Tabeand Dam, in California, is a very high earth dam (100 ft. high), built in layers having an average thickness of 6 ins. Mr. Burr Bassell, who was the chief engineer of this dam, has written a book ("Earth Dams") in which he gives the earth yardage moved each month and the maximum force of men used to excavate, haul and compact it. There are few high dams of this character in the world, and this Tabeand Dam so closely resembles the Ashokan Reservoir dikes that this board deems it wise to use some of the data given by Mr. Bassell, relating to costs. The contract price for the embankment, which was built in 1901, was 40 cts. per cubic yard. During the months of August, September and October, 1901, the average work done was more than 53,000 cu. yds. per month, or more than 2,000 cu. yds. per working day. Mr. Bassell states that the maximum force employed at any one time on this work was 233 men and 416 horses and mules. This work was done almost entirely by unskilled labor, buck scrapers being used to load wagons through "traps," and four horse wagons to haul the earth. Hence if we assume wages of $1.50 a day for laborers, which is now the price being paid at the Ashokan Reservoir, and $1 a working day for each horse and mule we have a total daily cost of $716, which is equivalent to 36 cts. per cu. yd., the output being 2,000 cu. yds. of embankment per day. The wagons, tools and machines are listed by Mr. Bassell and this board estimates that such a plant could be purchased for about $16,000. Allowing 3% per month for repairs, interest and depreciation, the daily plant charge would be about $20 or 1 ct. per cu. yd. Allowing 5% for general supervision, etc., would give an additional cost of 2 cts. per cu. yd., bringing the total up to 39 cts. per cu. yd. This work was done on a 10-hour day basis, and it is not improbable that the output would have been 15% less on an 8-hour day basis, which would have made the cost 45 cts. per cu. yd. paid for in embankment and measured once. While the average haul was short (¼ mile) the cost of loading was high, due to the fact that the work was practically all done with horses and men instead of with steam shovels. This work involved making only 370,000 cu. yds. of embankment, or about one-twentieth as much as will be built at the Ashokan Reservoir. It was, therefore, a comparatively small job as to quantities of earthwork, and, its cost could have been materially reduced had the work been of greater magnitude, as we shall indicate later.

"The Tabeand Dam is instructive not only in its general cost per cubic yard, but it is particularly instructive in certain details, namely the spreading, harrowing, sprinkling and rolling of the earth; for it is these details that differentiate reservoir embankments in large measure from railroad embankments. Mr. Bassell has given data from which the exact cost of these details on the Tabeand Dam can be closely estimated. To spread the 2,000 cu. yds. of embankment daily, there were 3 road graders operated by 6 horses and 2 men on each grader. There were 2 rollers, each operated by 6 horses and a driver. There were 3 sprinkling carts, each operated by 4 horses and a driver. There were 2 harrowers, and, while not stated, we assume 4 horses and a driver to each harrow. At $1.50 a day for men, and $1 for each horse, with a daily output of 2,000 cu. yds. of embankment, the cost per cubic yard was as follows:

Spreading with road graders	1.5 cts.
Sprinkling	0.8 cts.
Harrowing	0.6 cts.
Rolling	0.8 cts.
Total per cubic yard	3.7 cts.

"Adding even as much as 25% to reduce the 10-hour day to an 8-hour day basis, we have a total of only 4½ cts. per cu. yd. for these items. That the Tabeand Dam was thoroughly compacted is proved by two facts, namely: Test pits dug in the rolled embankment showed a weight of 133 lbs. per cu. ft., which, so far as this Board knows, is the most dense earth embankment ever secured. After a year's time the embankment had settled less than 2½ ins., although there was a head of 90 ft. of water against it. It cannot be claimed, therefore, that the rolling was insufficient."

Attention in the report was also called to the low cost of building the Wachusett dikes under Mr. Frederic P. Stearns, where nearly 7,000,000 cu. yds. of earth was stripped, for a foot in depth off of the reservoir site, by hand, and hauled in carts and cars for as great a distance as 5 miles, the prices varying from 18 to 39 cts. per cu. yd.

The work at Cobb's Hill Reservoir in Rochester, N. Y., where the contract price for earth excavation with a steam shovel is 18 cts. was mentioned, and also the steam shovel work done on the Cedar Grove Reservoir, built during the years 1901-04 for the city of Newark, N. J., under Mr. M. R. Sherrerd as chief engineer. Mr. Sherrerd stated to a member of this board that the cost varied, but after the work was well under way, the actual cost to the contractor was approximately 35 cts. per cu. yd. Mr. F. W. Abbott, one of the contractors for this reservoir, told one of the members of this advisory board that the actual cost averaged 42 cts. per cu. yd. when working in a material that was so bad that "its like cannot be found elsewhere in the whole United States outside of New Jersey." Other records of costs on this job corroborated Mr. Sherrerd's figures.

Reference in the report was also made to the earth excavation and embankment work that is being done on the New York State Barge Canal, and many prices quoted showing that contracts for this work were being done for less than the prices bid by the John Pierce Co.

However, the Advisory Board of Engineers did not depend upon contract prices to prove the reasonableness of the low bid, but placed their reliance on a cost analysis of the embankment work.

The following is an analysis of the estimated cost of building the Ashokan dikes with steam shovels, using small dump cars and dinkey locomotives:

ESTIMATED COST OF ROLLED EMBANKMENTS AT ASHOKAN.

Earth loaded with 65-ton shovel. Working season 7½ months (Apr. 15 to Nov. 30). Rainy weather reducing time to 20 days actually worked each month, or 150 days per working year. Each shovel averaging 12,000 cu. yds. per working month (90,000 cu. yds. in 7½ mos.), or 600 cu. yds. per day of 8 hours worked. A plant of 11 shovels will move all the earth in 7 years. Allow 2 extra shovels to take place of those laid off for large repairs.

Steam Shovel Expense. Per Day Worked.

1 shovel runner or engineer ($125 per mo.)	$6.25
1 craneman ($90 per mo.)	4.50
1 fireman ($60 per mo.)	3.00
6 pitmen at $1.50	9.00
½ foreman at $6.00 (or a cheap pit boss at $3)	3.00
1½ tons coal at $4.50	6.75
Oil and waste	0.75
Water	0.50
¾% of payroll for insurance of men	0.25
Total 600 cu. yds. at 5.83 cts.	$35.00
0.1% per day (= 2% per mo. of 20 days) of $9,000 (first cost of shovel) for repairs and deprecition	$9.00
6% annual interest on $10,800 (1.2 shovels) ÷ 150 days =	4.30
Total 600 cu. yds. at 8.05 cts.	$48.30

Transporting in Cars and Dumping.—Two small locomotives ("dinkeys") and 24 narrow gage dump cars having a capacity of 4 cu. yds. each, serving each shovel. The average haul, allowing for 2% grades, is less than 1 mile; but allow 2 miles track to each shovel. The first cost of the transportation plant would be:

2 dinkeys at $3,500	$7,000
24 cars at $200	4,800
Total	$11,800
Add 1/6 for extra rolling stock on hand	2,000
Total	$13 800

Track materials (2 miles):

112 tons (35-lb. rails) at $35	$3,920
3,600 ties (6"x6"x5') at 45 cts.	1,620
Track fastenings and switches	600
Total	$6,140
Labor delivering and laying 2 miles at $200	400
Labor grading 1 mile at $1,500	1,500
Total	$8,040

Each shovel will work about 1,000 days, using this track, hence if we distribute the full first cost of it ($8,000) over the 1,000 days, we have $8 a day, which is a liberal allowance since the rails will have more scrap value at the end of the job than will have been expended in the purchase of additional ties worn out.

Transporting by Rail and Dumping:

2 enginemen (on 2 dinkeys) at $75 mo. each	$7.50
2 trainmen at $50 mo.	5.00
14 dumpmen and trackmen at $1.50	21.00
1 dump boss at $75 mo.	3.75
1 water boy	1.25
0.8 ton coal for 2 dinkeys at $4.50	3.60
Oil and waste	0.50
Water	0.50
¾% of payroll for insurance	0.30
Total 600 cu. yds. at 8.2 cts.	$49.40
0.1% per day (= 2% mo.) repairs and depreciation of $13,800 rolling stock	13.80
6% interest on $13,800 ÷ 150 days worked	5.50
Cost of track materials, etc.	8.00
Total 600 cu. yds. at 12.8 cts.	$76.70

Spreading With Road Machine:

	Per Day.
2 men at $2	$4.00
6 horses at $1	6.00
0.2% per day on $300 road machine for repairs and depreciation	0.60
6% interest on $300 ÷ 150 days	0.12
Total 600 cu. yds. at 1.8 cts.	$10.72

Rolling:

1 engineman ($70 per mo.)	$3.50
⅓ ton coal at $4.50	1.50
Oil and waste	0.50
Water	0.50
Total 600 cu. yds. at 1 ct.	$6.00

0.08% per day on $2,500 steam roller for repairs and depreciation	2.00
6% interest on $2,500 ÷ 150 days	1.00
Total 600 cu. yds. at 1.5 cts.	$9.00

Harrowing:

(1 harrow serving 2 shovels, 1,200 cu. yds.)

1 driver	$2.00
4 horses	4.00
Total 1,200 cu. yds. at 0.5 ct.	$6.00

Interest and depreciation too small to be material.

Sprinkling:

Sprinkling done by 1 laborer with hose from pipe line. This man will sprinkle 600 cu. yds. a day, requiring 4 cu. ft. of water per cu. yd. of earth, or 250 lbs. of water per cu. yd. of earth, or 150,000 lbs. of water per 8-hour day per shovel. If the average height pumped is 100 ft. and the friction head is 200 ft. additional, there will be 150,000 × 300 = 45,000,000 ft. lbs. of work done per day in pumping the water for 600 cu. yds. of earth, or less than 100,000 ft. lbs. per minute, or 3 horsepower, which will require less than 1/10 ton coal.

Assuming 1 pumpman for 5 shovels, or 3,000 cu. yds. of earth daily, we have:

	Per Day.
1 pumpman	$3.00
5 men sprinkling at $1.50	7.50
½ ton coal at $4.50	2.25
Oil and waste	0.50
0.1% per day on $1,500 pumping plant for repairs, etc.	1.50
6% on 1,500 ÷ 150 days for interest	0.60
Total 3,000 cu. yds. at 0.5 cts.	$15.35

Pipe lines in place for sprinkling 7,000,000 cu. yds. of embankment, cost $14,000, or 0.2 cts. per cu. yd.

Removing Stones from Embankment:

In 600 cu. yds. of rolled embankment there will be less than 10% or 60 cu. yds. of removable stones; 10 men will readily gather and load these 60 cu. yds. (or 6 cu. yds. per man) in a day and 3 one-horse carts with a driver to each cart will readily haul them to the face of the embankment. Hence:

10 men loading at $1.50	$15.00
3 cart drivers at $1.50	4.50
3 horses at $1.00	3.00
1 man on the dump at $1.50	1.50
Total 60 cu. yds. stone removed at 40 cts.	$24.00

Or 600 cu. yds. of embankment stripped of stones at 4 cts. per cu. yd. of embankment.

SUMMARY.

	Per Cu. Yd.
Loading with steam shovel	8.1 cts.
Transporting by rail	12.8 cts.
Spreading	1.8 cts.
Rolling	1.5 cts.
Harrowing	0.5 cts.
Sprinkling and pipe line	0.7 cts.
Removing stones	4.0 cts.
Total	29.4 cts.
Add 7% for general expense	2.0 cts.
Total cost per cu. yd.	31.4 cts.

This general expense of 2 cts. per cu. yd. is made up of the following items for each steam shovel:

	Per Day Worked.
Interest on one month's payroll for 600 cu. yds. placed, $3,000 at 6% = $18	$0.90
Installing and removing each steam shovel plant, $1,000 ÷ 1,000 days worked	1.00
Housing plant over winters $1,500 ÷ 1,000 days	1.50
Housing men and horses $1,000 ÷ 1,000 days	1.00
Insurance on $30,000 plant at ½% for 150 days	1.00
1% premium on $35,000 bond, $350 ÷ 1,000 days	0.35
Sanitation $500 ÷ 1,000 days	0.50
Total	$6.25
General superintendence, office expense, etc.	6.00
Total general expense, 600 cu. yds. at 2 cts.	$12.25

The item of general expense includes all office expenses, traveling, superintendence of all kind, exclusive of foreman, and the allowance made is ample as is shown by numerous examples. The engineering of New York Subway cost less than 3%. The engineering on railroad construction is ordinarily about 3%, including all surveys, office work, inspection and other details.

The general expense on all the railways in the United States in the year 1904 amounted to 3.85%. (See ENGINEERING-CONTRACTING, June 19, 1907, p. 279, also annual report of Interstate Commerce Commission for 1904, page 90.)

The item of general expense on the Panama Canal for the fiscal year ending June 30, 1907, was 2½%, (see ENGINEERING-CONTRACTING Jan. 8, 1908, p. 34).

On the Chicago Drainage Canal the contractors' outlay "general expense," was about 6%, as shown on page 261 of Gillette's "Rock Excavation—Methods and Cost."

The Board of Advisory Engineers also showed in their report that, even if wagons and horses were used to transport the earth to the dikes, and expensive macadam roads were constructed to haul over, yet the John Pierce Co. bid would yield a profit.

Every cost analysis is based upon two assumptions, namely; (1) the rates of wages that will be paid; and (2) the daily output of the crews or machines. At the Ashokan Dam the Advisory Board of Engineers knew the wages being paid to laborers at work for the contractor in October, 1907, and also the wages paid to shovel men and train crews on work in various parts of New York State, which they believed would prevail at Ashokan. To be conservative, the Board of Advisory Engineers assumed an output of only 12,000 cu. yds, per month per steam shovel, or 600 cu. yds. per day for 20 days worked. Subsequently they discovered that a somewhat higher output had been assumed by the engineers of the Board of Water Supply.

The engineers for the Board of Water Supply have prepared progress profiles and charts, upon which they have mapped out the entire work, showing just what yardage shall be placed each season in the dikes and the number of shovels that must be kept at work to give these results. Reducing this to a daily basis, 20 days being worked to the month, their charts call for each shovel to place in the embankment an average of a little over 650 cu. yds.

(Continued next week.)

The Cost of Doing Scraper Work in Freezing Weather.

The excavation was done on a railroad cut in Maine, some years ago, during the early part of the winter before the heavy snows fell. The thermometer was below the freezing point during most of the day, and at night it frequently registered as low as zero. The contractor had one scraper gang at work and was anxious to keep his teams going as late in the season as possible, as he had a large amount of earthwork that would have to be done during the following summer.

The following wages were paid for a 10-hour day:

Foreman	$3.00
Laborers	1.50
Teams, 1 driver, 2 horses	3.50

The material could be classed as "average earth" as a 2-horse railroad plow would loosen it, and keep enough ground plowed for the scraper gang. Owing to the ground freezing, 4 horses had to be used on the plow, and plowing had to be done both day and night, or else the ground became so hard it could not be broken up. Places that were not plowed continually did freeze so hard that work had to be abandoned there until the following spring.

No. 3 Western wheelers with gates on them were used. The average haul was 250 ft., the material being carried in one direction only. Five scrapers were worked in the run, each scraper averaging 36 cu. yds. per day. As each scraper carried about ½ cu. yd., place measurement, this meant that the teams traveled about 9 miles per day. One man loaded the scraper, with the help of a 2-horse snatch team, the driver of this team hitching them to the scraper and unhitching them, as well as driving the team.

The cost per cubic yard for the work was as follows:

Foreman	$0.017
Scrapers	0.007
Plowing	0.004

Loading	0.008
Snatching	0.019
Dumping	0.008
Extra men	0.016
Total	$0.250

The two extra men were used to load the large frozen clods on top of the scraper, after it was loaded, and as it was about to pull away from behind the snatch team. One man stood on each side of the scraper, as it was being loaded with several large clods in his arms ready to throw them on, as the wheelers were loaded. If these clods became very plentiful at any particular place, these men would load several scrapers entirely with clods, by hand, and thus have them carried out of the cut. They did more of this work in the fore part of the day, as during the night a great many clods were made in the plowing. These men also kept up a wood fire at which the men could warm themselves from time to time.

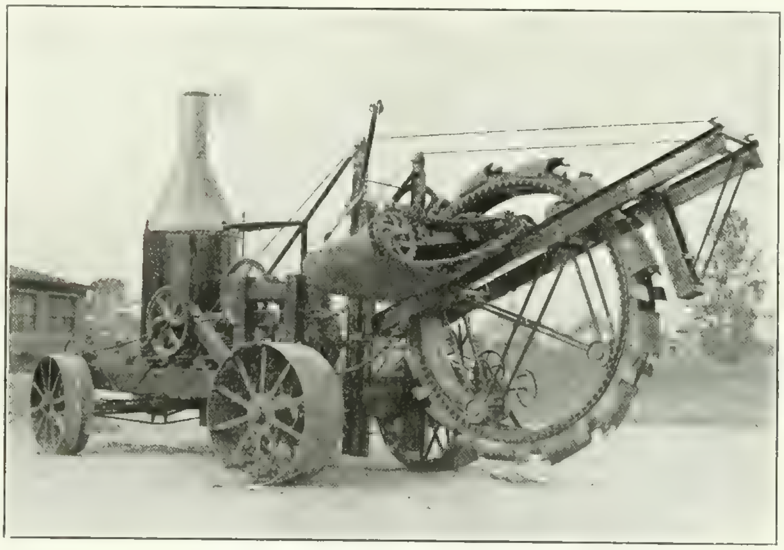
The cost of plowing was high, as plowing was done with 4 horses both day and night, as previously stated. If this had not been necessary the plowing could have been done for less than 3 cts. per cubic yard. Of the total cost per cubic yard, at least 8 cts. can be charged directly to the cold weather, and 2 or 3 cts. of indirect charges can also be accounted for in the same way, as in good weather this scraper work only cost the contractor, including general expenses, 15 or 16 cts. per cubic yard. His contract price for earth was 18 cts. per cubic yard, with a free haul of 800 ft., and he made money on his earth excavation.

The Cost of Digging a 36-Mile Trench With a Buckeye Traction Ditcher.

A wooden pipe line is used to bring the water from the mountains for the new water system of the city of Greeley, Colo. This line is 36 miles long. Of this distance 2,000 ft. was in rock. This part was excavated by hand and the rest of the trench was excavated by a Buckeye traction ditcher, manufactured by the Buckeye Traction Ditcher Co. of Findlay, O.

For eight miles the trench ran through a stratum of gravel, containing many stones,; some of the gravel was also cemented together. The material in the rest of the trench was clay, rather hard, but the machine dug it with great ease. In a ten hour day the machine in the gravel would dig from 600 ft. to 1,000 ft., while in the clay as much as 2,500 ft. of trench was dug in 10 hours. The style of machine used is shown in the accompanying cut. It was a 28-in. by 7½-ft. drainage machine. Such a machine is designed for digging ditches for draining land, the type meant for contractors' use in heavy trench work being more substantially constructed and of greater weight. This machine weighed 17 tons, while a contractors' machine of the same size would weigh 24 tons and cost $1,300 more than this machine did when new.

The Buckeye ditcher being a traction engine as well as a ditch digger, moves along automatically as it digs the trench. It throws the excavated material into the conveyor belt alongside of the wheel, and this belt dumps the earth clear of the ditch, so that the earth does not interfere with the pipe laying and other work that may have to be done in the trench. The bottom of the trench is rounded by the buckets on the wheel, so that pipe laid in the trench does not roll from side to side. Two men can operate the machine under favorable circumstances. In backfilling the material can be pushed into the trench by the ditcher, used as a traction engine, by fastening a plank to an outrigger, which acts in a manner similar to a snow plow. A drag scraper can also be used in back filling. The fact that the machine pulverizes the earth to a great extent in digging makes the back filling easier than when the earth is in chunks.


The Buckeye Traction Ditcher.

The trench dug at Greeley was throughout its entire length 30 ins. wide and 4 ft. deep. This meant that a lineal foot of trench contained 10 cu. ft. of earth or .37 cu. yd. As the total length of trench dug by the machine was 188,080 lin. ft., in all 69,659 cu. yds. of earth were excavated. All the work of excavating with the machine was done by 4 men. The man running the ditcher was paid $5 per day, and the other three $3 per day of 10 hours. The men worked 300 days. The ditcher when new cost $5,200, but this machine had been used before, and was bought by the contractors as a second hand machine.

In the summary of cost given below we have allowed $6 per day for repairs and renewals and interest and depreciation, which is 30 per cent per annum on the original cost of the machine. This would mean that the life of the machine was about 5 years. We are informed by the contractors that this machine used on an average of 1 ton of coal per day, the coal costing $5 per ton.

The cost of digging the trench was:

300 days, engineer	$1,500.00
900 days, helpers	2,700.00
300 tons coal	1,500.00
300 days, plant charges at $6	1,800.00
Total	$7,500.00

This cost, as will be seen, does not include any general expenses, the cost of getting the machine to and from the job or the cost of back filling.

The cost of water used for one of these machines is nominal, as they use about 1 gallon of water for each pound of coal.

The cost per lineal foot of trench for each item was:

Engineer	$0.008
Helpers	0.014
Coal	0.008
Plant	0.010
Total	$0.040

The average number of lineal feet dug per day was 627, although, as previously stated, much more than this was done when the ditcher was actually working. The average given includes all lost time. This machine is speeded to dig 3 lin. ft. of trench 3 ft. deep per minute, and 2 lin. ft. of 4½-ft. trench per minute. In good material better speed than this was obtained, but naturally it could not be made continuously. The same thing may be said in regard to the yardage excavated. On some days more than 900 cu. yds. of material were excavated, but the average yardage per day for the entire job was 232.

The cost per cubic yard for the work was as follows:

Engineer	$0.021
Helpers	0.040
Coal	0.021
Plant	0.025
Total	$0.107

This is low cost for trench excavation, even for a ditch only 4½ ft. deep.

The contractors for this work are the Jacobsen-Bade Co. of Portland, Oregon

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Formulas for Estimating the Quantities of Materials in Timber and Pile Trestles and Hints on Estimating Costs.

In our issue of June 19, 1907, we gave a new and rational formula for calculating the weight of steel viaducts, and also gave the detailed cost of several viaducts. The formula, for single track viaducts, deduced by us was as follows:

$W = 12 A + 600 L$.

W = weight of steel in viaduct in lbs.

A = profile area in sq. ft.

L = length of viaduct in feet.

A similar formula for timber trestles is also very useful in computing the approximate cost of a proposed trestle, and we shall now give such a formula.

The Northern Pacific Railway standard timber trestle consists of bents 15 ft. 9 ins. c. to c. Each bent has four 12x12-in. posts, the outside posts having a batter of 3 ins. per ft. and the inside posts a batter of 1 in. per ft. High trestles are built in stories, each story being about 25 ft. The deck consists of six stringers 9x18 ins., with 8x8-in. cross ties, 13½ ins. c. to c., and 5x8-in. guard rails.

From a carefully prepared and tabulated bill of material, we have deduced the following formulas:

(1) $M = L (220 + 6 H)$, for H between 0 and 25 ft.

(2) $M = L (240 + 8 H)$, for H between 25 and 50 ft.

(3) $M = L (240 + 9 H)$, for H between 50 and 75 ft.

(4) $M = L (240 + 10 H)$, for H between 75 and 125 ft.

M = ft. B. M. in trestle, including deck.

L = length of trestle in feet.

H = average height in feet from ground to a point 3½ ft. below base of rail.

In order to estimate the average height of a trestle, the more accurate way is to ascertain the profile area in square feet and divide by the length of the trestle in feet. Profile areas may be ascertained by the use of a planimeter, or by dividing the profile area into rhomboids, triangles or other figures easily measured. If it is desired to estimate the amount of timber direct from the profile area, without ascertaining the average height, then proceed as follows:

Let A = profile area in sq. ft. Then—

(5) $A = L H$.

Combining equations (1) and (5) we have:

(6) $M = 220 L + 6 A$, for heights under 25 ft.

In like manner equations (2) to (4) can be combined with equation (5).

There are about 35 lbs. of wrought iron and 15 lbs. (or, to be more exact, 12 lbs.) of cast iron per 1,000 ft. B. M. of trestle timber in the bents and braces, and nearly double this amount per 1,000 ft. B. M. of deck. The deck of the standard Northern Pacific trestle contains 164 ft. B. M. per lin. ft. of trestle, and for each 1,000 ft. B. M. there are 40 lbs. wrought iron, 25 lbs. cast iron and 25 lbs. galvanized iron. Therefore the total amount of iron in the deck is 90 lbs. per 1,000 ft. B. M. of deck, or 15 lbs. per lin. ft. of trestle. Hence, in estimating the amount of iron in a trestle, first ascertain the total ft. B. M., using equations (1) to (4). Then deduct $M = 164 L$, the deck timber, and multiply the remainder by 0.05; the product will be the total number of pounds of iron in the trestle exclusive of that in the deck. To this add 15 lbs. per lin. ft. for the iron in the deck. Or the total amount of iron in bents, deck, etc., may be arrived at directly by the following formulas, derived from eqs. (1) to (4).

(7) $W = L (18 + 0.3 H)$, for H between 0 and 25.

(8) $W = L (18 + 0.4 H)$, for H between 25 and 50.

(9) $W = L (18 + 0.45 H)$, for H between 50 and 75.

(10) $W = L (18 + 0.5 H)$, for H between 75 and 125.

From equations (7) to (10) and (1) to (4) we deduce (dividing one equation by the other) the following approximate relations:

Trestle 25 ft. high, 70 lbs. iron per 1,000 ft. B. M.

Trestle 50 ft. high, 60 lbs. iron per 1,000 ft. B. M.

Trestle 75 ft. high, 56 lbs. iron per 1,000 ft. B. M.

Trestle 100 ft. high, 55 lbs. iron per 1,000 ft. B. M.

Having ascertained the quantity of timber, the unit price to be used may be arrived at thus:

	Per M.
Timber, f. o. b.	$20.00
Freight, 1.8 tons, 200 miles, at ½ ct. ton mile	1.80
Iron, 70 lbs., at 3 cts. delivered	2.10
Labor framing and erecting	10.00
Total in place	$33.90

With bridge carpenters at $2.50, the labor item should rarely exceed $10 per 1,000 ft. B. M., including, of course, the labor of handling the iron.

The quantity of material in a pile trestle is easily estimated. With four piles to the bent, bents spaced 16 ft. c. to c., and 20 ft. allowed for penetration of each pile and for cut off at the top, the following formula gives the number of lineal feet of piles per lineal foot of trestle:

$$P = \frac{L (H + 20)}{4} \qquad (11)$$

P = total in ft. of piles.

H = average height of trestle in ft. measured from the ground to a point 3½ ft. below base of rail.

L = length of trestle in ft.

The amount of sawed timber is given by the following formula:

(12) $M = 185 L$, for trestles under 15 ft. high.

(13) $M = 200 L$, for trestles 15 to 25 ft. high.

M = total number of ft. B. M.

The weight of iron is given by—

(14) $W = 16 L$, of which 40 per cent is wrought, 30 per cent cast, and 30 per cent galvanized iron. This is equivalent to about 80 lbs. of iron per 1,000 ft. B. M.

The unit cost of the timber in place may be estimated as above, and the cost of the piling may be estimated thus:

	Lin. Ft.
Piles f. o. b. cars	$0.10
Freight, 40 lbs., 400 mi. at ½ ct. ton mile	0.04
Labor, etc., driving 35 ft. piles	0.07
Total	$0.21

Each pile should ordinarily be driven for less than $2.50.

The average height of all the timber and pile trestles on the Northern Pacific and Great Northern Railways in the state of Washington is 18½ ft. from ground level to base of rail. This average height was computed from the profile areas of the trestles, and is not a rough approximation. Hence H = 15 ft., and substituting in equation (1), we have 310 ft. B. M. per lin. ft. of the average trestle. With timber at $35 per M (including iron) the cost would be $10.85 per lin. ft. of timber trestle. For a pile trestle of the same height there would be, according to equations (11) and (12), 9 lin. ft. piles, 185 ft. B. M. timber per lin. ft. of trestle. At 21 cts. per lin. ft. of piles and $35 per M. of timber (including iron) the cost would be $8.36 per lin. ft. of pile trestle.

The foregoing prices are merely illustrative of correct methods of estimating the probable cost of trestles. Most railways charge themselves ½ ct. per ton mile for all freight carried over their own lines, but a contractor might have to pay considerably more for freight.

The timber used for floor beams usually costs a few dollars more per M. than timber for other parts of a trestle. Timber for bridge ties is usually somewhat less expensive than timber for caps, posts, etc. Quotations from dealers will readily enable an engineer to estimate an average price to be assumed for all the timber in a trestle. For illustrative examples of actual cost of timber work and pile driving see Gillette's "Handbook of Cost Data."

Methods and Costs; Some Old, Some New.

Life of Telephone Equipment.—Some time ago the city of Chicago appointed a special commission, consisting of Prof. Dugald C. Jackson, Dr. George W. Wilder and William H. Crumb, to investigate matters pertaining to the telephone situation in that city. In connection with its report the commission gave the following data as to the life and depreciation of telephone equipment:

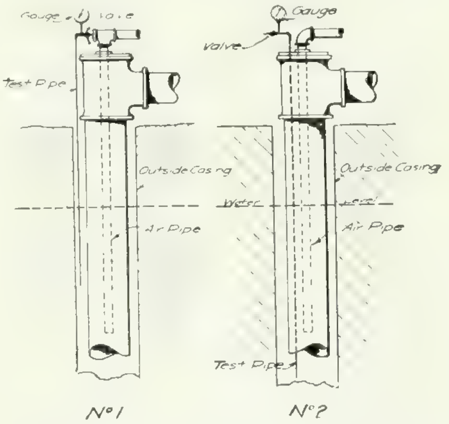
Property.	Life in Years.	Per Cent to Depreciation Account.	Per Cent Salvage.	Per Cent to Reconstruction and Insurance.
Underground conduit, main, clay in concrete	50	.89	0	1½
Underground conduit, main, fibre, etc.	20	3.72	0	1½
Underground conduit, subsidiary..	20	3.72	0	2
Underground cable, main	20	3.72	..	2
Underground cable, subsidiary	15	5.38	40	2
Aerial cable	15	5.38	..	3
Poles, including crossarms, etc. ..	10	8.73	0	4½
Aerial strand	12	7.05	0	3½
Aerial cable, terminals	12	7.05	0	3
Aerial wire, copper.	15	5.38	70	3
Drop wires, copper.	8	11.25	15	4
Subscribers' station instruments	10	8.73	5	2
Private branch exchange switchboards	8	11.25	20	2
Central office switchboards	8	11.25	20	2
Buildings, fireproof.	40	1.33	0	1
Teams, tools, furniture, etc.	4	23.92	10	0

Sewer Underdrains.—In the construction of a vitrified pipe sewer wooden underdrains were used to support the pipe in wet trenches and on quicksand. They consisted of four pieces of 2x4 in. plank laid flat 6 ins. between centers, on top of which were nailed pieces of 4x4 in. timber 1½ ft. between centers. The 4x4 in. pieces supported the pipe, holding it in position until the backfilling was placed around and under it, by means of wooden wedges between the 4x4 in. pieces and the pipe. The length of the 2x4 in. plank was about 9 ft. The number of 2x4 in. pieces and the length of the 4x4 in. blocks varied with the size of the pipe to be laid. The space under the supported pipe and the space between the 2x4 in. pieces served as a channel to drain away the water to the sump pit, allowing the joints to be cemented and kept dry until they set. Coarse gravel filling in the space between the 2x4 in. and the 4x4 in. pieces worked well to drain the trenches in quicksand.

Breaking Up Clay.—The foundation walls for a bridge were sunk through sand and clay, the latter being dark blue and very hard. It was brittle when quite dry, but like leather when under water. A dredge was used to remove the overlying sand but could make no impression on the clay. Accordingly the following method of breaking up the clay was employed: Five double-headed rails each 20 ft. long, and weighing 64 pounds per yard, were riveted together. The two outer rails were splayed outward like a trident and were sharpened. The center rail was also sharpened, and the two others were cut off at about 2½ ft. from the end. This arrangement was worked up and down by a steam hoist, and, being top heavy, when it was driven into the clay it tended to fall over, thus breaking up the clay. In this manner a hole 1 ft. deep and 13½ ft. in diameter could be dug and dredged in 24 hours.

Sinking a Shaft Through Quicksand.—A hoisting shaft for a mine was sunk through 57 ft. of dry sand, 50 ft of quicksand and 31 ft. of hardpan. The shaft was 6x16 ft., inside dimensions, divided into three compartments, with the usual timbering to the water line. Previous to the sinking of this shaft a small shaft, 8x10 ft., inside diameter, had been sunk close to where the larger one was to go, and this partially drained the quicksand. In sinking the shaft through the quicksand, the following method was employed: A drop section of shaft timbers of full size of shaft was framed and placed in position. This drop section was 4 ft. in depth, made of 12x12 in. timbers bolted together and braced. The lower two sets were beveled flush outside and ⅛ in. plate of steel shaped to fit the edge was fastened by spikes, making a shoe 3 ins. wide to cut the sand. Outside of this drop section was bolted a sheeting of plank, with lower edges hewn thin, so as to offer less resistance to sand. The upper ends of the plank extended 3½ ft. above the timber and behind the last permanent shaft timbers. From 20 to 30 2½x18 in. jacks were operated between the drop section and the last permanent timbers, the plank sheeting serving to retain the sand. As the jacks forced down the drop section they were removed for the time being, and timbers placed and bolted to the last permanent timbers; to bring the permanent timbers close together pockets were cut out for nuts and washers. The process was repeated until clay was reached, after which lath was driven, the ground removed, and the timbering put in. During the entire process of the work a sheet steel box was forced in advance of the timbers. This box was 3x5 ft. in size, and 10 ft. long; it was made of ¼ in. plates put together with angle irons. It was forced down in the middle of the shaft and served to partially drain the bottom, also acting as a sump. As an additional precaution against the shaft getting out of line diagonal braces were placed from the collar of the shaft down to a depth of 85 ft. The shaft timbers were hung by wire ropes from the beams at the collar of the shaft. The shaft was sunk through quicksand at a rate of 8½ to 9½ ft. per month, work being carried on continuously, except Sundays.

Water Level Gage.—In the testing of deep wells one of the most troublesome operations often is the measurement of the lift when the pump is operating. An observation of the water level when the pump is not running will not suffice, as in operation the water level may fall away in a very considerable amount. An electric device depending upon an insulated wire dropped into the well which closes a circuit with the well casing when the water level is touched, is sometimes used where there is sufficient space between the casing and water pipe. Often times, however, this space is not available. In a paper by Mr. Charles B. Burdick, read before the Western Society of Engineers, and printed in the journal of the society, is described the accompanying device which has been used for the above purpose for ten years or more. The device consists of a small pipe (¼ in. will do), or valve, and a pressure gage so graduated that it can be read to 1 lb. or less. A known length of pipe is dropped into the well; air pressure is then applied until the water is driven from the pipe, as evidenced by the refusal of the gage to rise further. This pressure reduced to feet shows the amount of submergence of the end of the pipe. The accompanying cut shows the arrangement coupled to an air lift pump. In No. 1 of the figure is shown an application to a case where the exterior of the water pipe is accessible. Upon an air lift when this can be done the compressed air can be obtained by tapping the air pipe. No. 2 shows an application to an air lift where there is no room outside, and with this arrangement a hand air pump is desirable as the pressure required in the test pipe is a little in excess of that in the air pipe. The ordinary beer pump or large bicycle air pump answers this purpose nicely. Applied in this way the lift can be measured readily, even when the well casing is used as a discharge pipe



Device for Measuring Water Level.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0567. **Direct Current Motor Starting Devices.**—General Electric Co., Schenectady, N. Y.

This bulletin describes lines of motor starting rheostats and panels for direct current. The rheostats contain an improved enclosed type resistance unit consisting of a low temperature co-efficient resistance wire wound on a strong tube that is not brittle. The unit is treated with a special compound which forms a coating both inside and out, making a strong and solid construction and is thoroughly baked before being placed in the rheostat. Rheostats with no-voltage release and those with both no-voltage and overload release are illustrated and described, as well as rheostats for starting reversible shunt or compound wound constant speed motors. In order to facilitate the installation of motor starting devices the company has perfected a line of motor starting panels in which there is no multiplicity of the terminals to give trouble from bad or incorrect connections, space, labor and time are saved; maintenance is reduced, and satisfactory operation, immediate and permanent, is obtained. The bulletin shows a variety of these panels in which different types of starting rheostats are used, the rheostat being combined with a line switch and fuses, or with a double-pole circuit breaker. Dimension diagrams for the different capacities of rheostats and panels are included.

No. 0568. **Trench Excavator.**—Geo. F. Lambert, Des Moines, Ia.

This pamphlet of 16 pages contains a number of illustrations of the Parsons Trench Excavator accompanied by a really excellent description of the machine and its operation. The engineer who is at all interested in trench excavation by machine should secure a copy of this pamphlet.

No. 0569. **Rosendale Cement.**—Consolidated Rosendale Cement Co., New York.

This handsomely printed book is devoted almost entirely to halftone illustrations of prominent buildings in the construction of which Rosendale Cement has been used. Each halftone is printed on a separate sheet and the whole work is very artistically done. To introduce the halftones there are several pages of text describing the method of quarrying Rosendale Cement Rock and preparing it for the market. Several views are given of the factories and quarries.

No. 0570. **Contractors' Tents.**—Murray Tent & Awning Co., Chicago, Ill.

The tents illustrated in this pamphlet are those designed particularly for Railroad Contractors' use. Each style of tent is illustrated and its cost and all the principal dimensions are listed in tabular form. The list of stable tents is very complete.

No. 0571. **Heating and Ventilation.**—Sirocco Eng. Co., New York City.

This series of pamphlets describes both Sirocco Induced Draft Fans and the Sirocco Propeller Fan giving the main structural features and catalog dimensions, capacity, etc. Two of the pamphlets are devoted to the ventilation of public buildings and of industrial buildings. These two pamphlets are especially well written and printed and should be secured by anyone interested in ventilation.

No. 0572. **Concrete Mixers.**—The W. H. Wilcox Co., Binghamton, N. Y.

This 16-page pamphlet describes and illustrates the Foote Batch Mixer. The advantages of this mixer are briefly presented and tables are given showing dimensions and capacity.

No. 0573. **Mill Type Motors.**—General Electric Co., Schenectady, N. Y.

Mill Type Motors are described in this Bulletin. These motors are manufactured for direct and also for alternating current circuits and are designated MD and MI motors respectively. They are built in sizes from 30 to 150 HP., and the direct current motors, while generally rated at 220 volts, can be supplied for 500 volts with a slight variation for standard speed. The MI alternating current motors are wound for either 220 or 440 volts, 25 cycles, three-phase. The illustrations in the Bulletin show the particularly heavy construction and dimension diagrams with other data are given in the text. The motors are totally inclosed, dust-proof, and are intended for use on heavy and intermittent loads. Mechanically and electrically strong, they are suitable for operating rolling mills, hoists, turn tables, conveying machinery, etc.

No. 0574. **Cement Brick Machine.**—Queen City Brick Machine Co., Traverse City, Mich.

This 8-page circular gives a very good general description of the construction and operating of the Pressed Cement Brick Machine manufactured by the company named. Methods of molding, curing and laying cement brick are briefly described.

No. 0575. **Concrete Mixers.**—The Kent Machine Co., Kent, Ohio.

The Mixer described in this pamphlet is of the continuous type provided with automatic measuring hoppers. The machine is briefly described and its merits pointed out for various classes of work.

No. 0576. **Concrete Block Machine.**—Hydraulic Concrete Machine Co., Buffalo, New York.

This pamphlet describes a two-piece Concrete Block Machine and gives several illustrations showing the method of constructing walls using this two-piece block. The pamphlet is worth securing.

No. 0577. **Fence and Entrance Gates.**—F. E. Carpenter Co., New York.

This company manufactures a complete line of ornamental iron work for fences and gates. The more important of its designs are illustrated in this 56-page pamphlet and brief descriptions and the usual catalog matter are given.

No. 0578. **Scrapers and Wheelbarrows.**—Kilbourne & Jacobs Mfg. Co., Columbus, O.

This company manufactures a very complete line of Drag and Wheel Scrapers, Wheelbarrows, Dump Carts, Grading Plows, etc. This 92-page pamphlet illustrates the more important patterns of these tools, describes their construction briefly and gives tables showing dimensions, cost, etc. The line of scrapers and wheelbarrows is particularly complete and should make the pamphlet of interest to contractors.

No. 0579. **Steel Centers for Sewers.**—Blaw Collapsible Steel Centering Co., Pittsburg, Pa.

This handsomely printed pamphlet of 67 pages illustrates the construction and describes the use of the Blaw Collapsible Steel Center for constructing concrete sewers and water-pipe. The construction features of the centers are described in detail and its advantages in the way of durability, collapsibility, etc., are clearly pointed out. Following the catalog matter proper there is an argument showing the advantages of concrete for sewer construction and a set of specifications for concrete sewer work.

No. 0580. **Crushing and Road Building Machinery.**—American Road Machine Co., Kennett Square, Pa.

This company manufactures a complete line of Rock Crushers, Rollers, Dump Wagons, Scrapers, etc., for road building. The Rock Crusher made by this firm is described in very considerable detail. There are also interesting sections on Bins and Elevators and on the company's Special Reversible Road Machine.

No. 0581. **Grinding Machinery.**—Raymond Impact Pulverizer Co., Chicago.

This 80-page pamphlet describes and illustrates the various sizes and styles of Pulverizing Machinery made by the firm named. The Mills and Pulverizers are all built special for air separators that are adapted to grinding all kinds of materials, and by means of the air separators to do the grinding without causing dust. The pamphlet is well gotten up and should be of interest to everyone desiring to investigate grinding machinery.

No. 0582. **Mechanical Rubber Goods.**—The Gutta Percha Rubber Mfg. Co., New York.

This company manufactures a complete line of Rubber Belting, Packing Hose, etc., for mechanical purposes. The various sizes of belting and other supplies are described and illustrated in this 77-page pamphlet. The pamphlet is very handsomely gotten up and the information is conveniently arranged for use. Those interested in this class of goods would do well to secure the pamphlet and place it on file.

No. 0583—**Camel Hair Belting.**—Rosendale Reddaway, Newark, N. J.

This 16-page circular describes the merits of camel hair belting, gives tables of weights and dimensions and directions for splicing and repairing belts.

Personals.

Mr. J. I. Hudson has been appointed City Engineer of Portsmouth, O.

Mr. Wm. E. Fox has organized the Wolcott Dredging Co., of Wolcott, Ind., and will engage in a general contracting business.

Mr. Charles Young has been appointed Chief Engineer of the St. Louis & Oklahoma Southern Ry., now in course of construction.

The Engineers' Club of Minneapolis has elected the following officers: President, L. S. Gillette; Vice-President, W. B. Cowles; Secretary, L. Clausing; Treasurer, H. A. Graw.

First Lieutenant Wildurr Willing, Corps of Engineers, U. S. A., has been relieved from temporary duty in the office of the Chief of Engineers and will go to New Orleans and report to Major James F. McIndoe for duty.

Mr. H. W. Nutt, who for the past year has represented Buell & Mitchell, of New York, in Boston, has been appointed District Manager for the New England States by the General Fireproofing Co. and will have headquarters at 161 Devonshire St., Boston.

Mr. D. G. Seymour, formerly Resident Engineer in charge of the construction of the Stevenson Extension of the Southern Ry., has entered the employ of T. J. Shea, Contractor, Chattanooga, Tenn., as Constructing Engineer, and among other work will have charge of the excavation of the tunnel through Missionary Ridge.

Owing to the retirement of Brig. Gen. Medorem Crawford, U. S. A., the following promotions in the Engineer Corps have been made: Col. C. E. L. B. Davis, to be a Brigadier General; Lieut. Col. Wm. H. Bixby, to be a Colonel; Maj. Lansing H. Beach, to be a Lieutenant Colonel; Capt. Jay J. Morrow, to be a Major.

Daniel Shafer, one of the best known salesmen and engineers in the South, died Jan. 24, at the Nashville Hotel, Nashville, Tenn., from a sudden attack of pneumonia. Mr. Shafer, who was 47 years of age at his death, had been associated for the past three years with Allis-Chalmers Co., of Milwaukee, being attached during a portion of that time to the Pumping Engine Department, and for the past year as Sales Engineer of the Steam Turbine Department. For five years previous to taking his position with the Milwaukee company he was associated with the Hoovens-Owen Rentscheller Co., of Hamilton, O., during which time he acted as their southern representative, and was well known throughout that section as an expert on the power equipment of cotton mills.

The following transfers and assignments have recently been made in the U. S. Reclamation Service: Mr. J. T. Burke, Engineer, has been transferred from Payette-Boise Project, Idaho, to Yuma Project, Ariz. Mr. George R. Guernsey, Junior Engineer, has been assigned to the Minidoka Project, Idaho. Mr. Philip H Glover, Junior Engineer, has been assigned to the Minidoka Project. Mr. Luther E. Johnson, Junior Engineer, has been assinged to the Minidoka Project. Mr. Harvey M. Schilling, Junior Engineer, has been transferred from the Truckee-Carson Project to the Minidoka Project. Mr. Sheldon K. Baker, Assistant Engineer, has been transferred from the Lower Yellowstone Project to the Salt River Project. Mr. Orrin C. Smith, Junior Engineer, has been transferred from Oklahoma to the North Platte Project.

O. F. Nichols, Consulting Engineer to the Department of Bridges of New York City, and formerly Chief Engineer of that Department, died suddenly, Feb. 4, at his home in Brooklyn, N. Y. Mr. Nichols was graduated from Rensselaer Polytechnic Institute in 1868, and his first professional duty was in connection with the laying out of Prospect Park, in Brooklyn. From 1871 to 1875 he was in Peru on work in connection with the construction of the Chimbote R. R. On his return to the United States he became an assistant engineer in the Edgemoor Bridge Works, leaving this position to become engineer in charge of a considerable part of the sewerage work in New York. In 1878 he went to Brazil, where he was resident engineer on the Maderia & Mamore R. R. project. He did considerable work in connection with the construction of various street railways in New York City, and from 1888 to 1895 served as Chief Engineer and also General Manager of the Brooklyn Elevated Ry. In 1896 he became connected with the Department of Bridges of New York City, assuming charge of the construction of the Williamsburg bridge over the East River. He was appointed Chief Engineer of the Department in 1903, remaining in that position until 1906, when he was succeeded by Mr. C. M. Ingersoll. Since 1906 Mr. Nichols has been consulting engineer of the Department.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5652-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER,
CHAS. S. HILL,
C. T. MURRAY,
F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class matter April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:
Why Appoint a Commission of Business Men for an Engineering Project? 107
Tests Showing the Effects of the Hammer Rope in Decreasing the Effectiveness of a Pile Hammer Blow 107
CONCRETE SECTION:
Proportions Used and Methods of Mixing Concrete 108
EARTH AND ROCK SECTION:
The Estimated Cost of the Ashokan Reservoir and Data of Actual Cost of Similar Earth Embankments, Together with a Discussion of the Testimony Submitted in the Investigation of the Ashokan Dam Award. 111
GENERAL ARTICLES:
Some Pile Driving Experiments in Connection With the Construction of the Charles River Dam 115
METHODS AND COSTS:
Form for Concrete Column—Data on Cut Stone Work—Lining Mine Shafts—Cost of Briquetting Coal—Cost of a Railway Survey 117
CATALOGS WORTH HAVING 118
PERSONALS 118

"You Don't Appoint a Commission of Shoe Makers to Stamp Out Yellow Fever—Why, Then, a Commission of Business Men for an Engineering Project?"

This is the question put by an ex-mayor of Baltimore to the people of Baltimore. Since the same question will be put, with growing frequency, to the people of every city in America, we shall quote at some length from the Baltimore Sun, wherein ex-Mayor Thomas G. Hayes voices his views in a most vigorous manner.

As many of our readers know, a commission of business men was appointed to build a sewerage system in Baltimore, at an estimated cost of $10,000,000. The estimate has proved to be far too low, and dissatisfied taxpayers are demanding that the present commission be legislated out of office.

Mr. Thomas G. Hayes, ex-mayor of the city, recommends that a commission of five, three to be engineers, should be substituted for the present commission of seven business men. He says:

"There never was a time when the present commission should not have been legislated out of office and a new commission of practical men who know the conditions underground in Baltimore placed there.

"The members of the present commission are, no doubt, all estimable gentlemen. I have the pleasure of knowing several of them. They are all men who stand well in their particular callings, but these callings have nothing to do with the building of sewers, and their actual service to the city is nothing. Therefore, why continue them in office?

"It is of course argued at once, when that assertion is made, that engineers are not necessary on the commission, but rather good business men. That is as far from being logical as anything I know. You don't form a commission of shoemakers to stamp out yellow fever in a city or island, do you? Well, why form a commission of plain business men to build $10,000,000 worth of sewers? Why not put there men who know how to build sewers, and if they have not the same amount of business sagacity as the business man then they have no right to be engineers.

"To my mind the real worth which the city will get from each man on that commission is not the judgment he will display in saving the city money on sewerage plans prepared by an engineer from another city, but will come when they all use their knowledge to restrain that engineer from planning schemes which will cost the city money needlessly. Business sagacity when it is restricted to application only to one plan, of which they have no intimate knowledge, is of little value.

"The commission which should be appointed in place of the present one is this: Mayor Mahool, City Engineer Fendall, Water Engineer Quick, Electrical Engineer Phelps and then another man who is also practical. Because of the fact that three I have named are Democrats it would be necessary to have the other man a Republican—but no matter if he is a Republican, mugwump or Hindu, have him with some practical knowledge of what it means to put $10,000,000 worth of sewer pipes under the ground in Baltimore and also some idea of how to do it.

"Now, look at that commission. There is Quick, who has been laying water pipes for eight years; there is Fendall, who has been laying sewers and storm-water drains for eight years; there is Phelps, who has been putting in subways for longer than that. What those men should know about the underground pipe construction of Baltimore should, in unison, be an amalgamation which would work beautifully in putting in a sewerage system which would not cost thousands of dollars every time they hit an existing pipe.

"That commission could have a sewerage engineer in its employ, but the commission could be boss and the engineer the employe—not as it is at present, as I understand, the engineer the head and front of the work and the commission following his recommendations. This new commission would be composed of men who could give him practical advice upon just what conditions exist in Baltimore."

We heartily commend Mr. Hayes' recommendation. Many cities would profit by having just such commissions, as was illustrated in New York in the recent award of the contract for the Ashokan Dam, when the work was given to other than the lowest bidder, at an increase of about $2,300,000. The commissioners of the Board of Water Supply, these business men, awarded this contract on the recommendation of their engineer. If this board had been made up of three engineers this money would, no doubt, have been saved to the city of New York, for then, as Mr. Hayes says, "The commission could be boss and the engineer the employe—not as it is at present, as I understand, the engineer the head and front of the work and the commission following his recommendations."

It may be asked what gain there will be in substituting a commission of engineers who *direct* their engineers for a commission of business men who *follow* their engineers. Just this: The wholesome incentive to the designing engineer that springs from a knowledge that his designs are to be criticized by a board of engineers and not merely passed upon by a commission of business men who are wholly ignorant of engineering. Moreover, as we have previously pointed out, a board of business men is usually incapable of judging whether its engineers are good, bad or indifferent. Whereas, a board of engineers has, at least some criteria by which to measure up its men.

Tests Showing the Effects of the Hammer Rope in Decreasing the Effectiveness of a Pile Hammer Blow.

Elsewhere we print an interesting record of pile driving, in which the Engineering News formula was applied. The author quotes "Engineering News" to the effect that a free falling hammer will cause a pile penetration about twice as great as occurs with a friction clutch driver whose hammer rope is constantly attached to the hammer. So far as we know the truth

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

of this statement has never been demonstrated and we are now able to lay before our readers a record of tests which indicate that the hammer rope has far less retarding effect on the hammer than is assumed in the quotation mentioned.

These tests were made by Mr. James C. Haugh when he was resident engineer of the New Orleans and North-Eastern Railroad Co. They were made at the request of the managing editor of this journal, and were as follows:

A 3,675-lb. hammer was allowed to drop 20 ft., attached to a 2-in. manilla rope, worn enough to be as flexible as such a rope should be. The pile was 15 ft. in the ground, which was firm clay for several feet underlaid with sand. The penetration of the pile averaged 0.15 ft. for six blows, when the rope was attached to the hammer. The hammer was then hoisted 20 ft., and the hammer rope was cut so as to secure a free fall. As a result, the penetration of the pile under this blow was 0.19 ft. Therefore the penetration of the pile under the blow of the hammer with the rope attached was 20 per cent less than under a free fall.

Another test was subsequently made, ten blows being struck with the hammer, rope attached, and with a drop of 10 ft., giving a total penetration of 14 ins., or 1.4 ins. per blow. When the line was cut the penetration was 1.75 ins. under a 10-ft. free fall. This, likewise, shows a reduced effectiveness of 20 per cent due to the retarding influence of the hammer rope.

A third test was made, using a 30-ft. drop. Under 9 blows from the hammer, with rope attached, the penetration was 23 ins., or 2.55 ins. per blow. When the line was cut the penetration was 3 ins. under a 30 ft. free fall. This shows a decrease in penetration of 15 per cent due to the retarding influence of the hammer rope. This last test indicates that the higher the drop the less influence the hammer rope has in retarding the final velocity of the hammer.

It will be noted that the hammer in this case was quite heavy. It is altogether likely that a lighter hammer would be retarded to a greater degree, but it seems probable, without further experiments, that "Engineering News" assumption, above mentioned, exaggerates the effect of the hammer line on the efficiency of the hammer.

The experiment is such a simple one that, we trust, some of our readers will make similar tests and submit the results for publication.

The following is a list of the railway equipment used in the construction of the Isthmian Canal and in service at the end of the year 1907: 157 American locomotives, 104 French locomotives, 1,340 40-ton flat cars, 124 50-ton flat cars, 299 12-yard American dump cars, 241 20-yard American dump cars, 461 6-metre French dump cars.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Proportions Used and Methods of Mixing Concrete.*

BY L. C. WASON.†

The necessity of thorough mixing has been universally known for many years. The loss of strength from poor mixing is not perhaps so well known in figures. There were some private tests made at the Watertown Arsenal about eight years ago in which the writer was interested, which throw some light upon improper mixing. On a large job a certain type of mixer was disapproved of by the supervising engineer, who insisted upon a comparative test of machine and hand mixed concrete. All concrete was made with proportions of 1 part of cement, 3 of sand and 5 of broken stone ranging from 2½ ins. to ½ in., and was molded into 1 ft. cubes. A full size batch was first made with machine without any previous dry mixing of the aggregates. As the material was dumped from the mixer a cone was allowed to form, down the sides of which quite a quantity of stone rolled, separating from the mortar and accumulating around the base of the cone. A second batch was made, the cement and sand being thoroughly dry mixed before adding the stone, and then thoroughly mixed together when in the mixer. No cone was allowed to form. A third batch was mixed by hand, being turned five times, the engineer with a hoe throwing into the mass stones which became accidentally separated from it. In filling the molds the engineer insisted that from the first batch, stone be shoveled up from around the base of the cone. The rest of the batch which remained properly mixed was filled into other molds, four cubes and two beams being made from each batch.

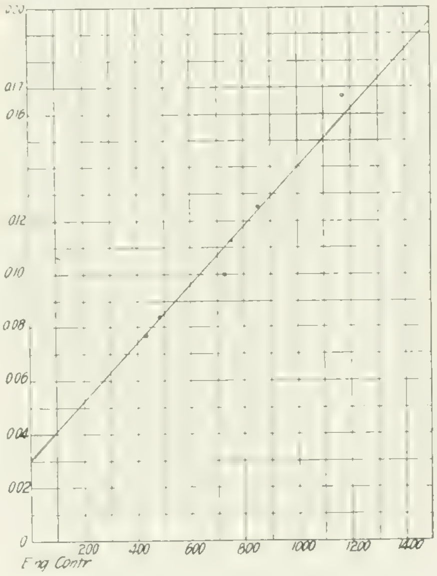


Diagram Showing the Relation Between Amount of Cement Used and the Strength of the Concrete.

$$\text{Ordinates} = \frac{\text{Volume of Cement}}{\text{Volume of Concrete}}$$

Abscissa = Ultimate Strength in lbs. per sq. in.

$$Y = mx + b$$

$$Y = .00011\,X + .03 \text{ or } X = 9091\,Y + 273$$

The first cube averaged only 2⅓ lbs., or about 2 per cent lighter than the other three cubes, due to lack of mortar. Nevertheless it gave a result 28 per cent below that of the average of the other three, the figures being 3,081 lbs. per sq. in. as against 4,263 lbs. per sq. in., the average of the other three. The age of all specimens was 90 days. The average of the four cubes which were dry mixed before mixing in the machine was 4,133 lbs. The hand mixed specimens averaged 3,187 lbs. It will be seen that there is an advantage in machine mixed concrete over that made by hand of of 25¼ per cent, and that which was not dry mixed before putting into the machine gave 3⅓ per cent greater strength than that which was. The machine used in this case was the Portable Gravity concrete mixer.

It is safe to assume that these specimens were more carefully made than under ordinary commercial conditions, which they tried to reproduce, and the marked weakness of the specimen which lacked but a small amount of mortar is very significant. The weakness is doubtless due to the voids in the material reducing the cross sectional area.

Ten years ago another series of experiments was conducted by the writer at the Watertown Arsenal, giving the relative merits of machine and hand mixed concrete and the strength of various mixtures. A cylindrical drum batch mixer was used. These were specimens 1 ft. square and varying from 6 to 14 ft. in length. They were all made in midwinter in an open lumber shed and remained in the open air until tested, which accounts for the low ultimate strength. The modulus of elasticity of the hand mixed specimens with proportions of 1—3—6 and averaging age of 43 days at a stress of 700 lbs. per sq. in, was 2,500,000, that of the machine mixed specimens was 2,870,000, an increase of 12½ per cent of the modulus. The ultimate strength of the hand mixed was 921 lbs. and of the machine mixed, 1,111 lbs., an increase in the ultimate strength of 17 per cent, due to machine mixing. The hand mixed specimens in this case were somewhat better than commercial conditions because in order to fill the molds the concrete was handled several times more than would be necessary in placing ordinary work. Each handling was equivalent to a mixing.

---

*Read at the Buffalo Convention, National Association of Cement Users, January, 1908.

†President, Aberthaw Construction Co., Boston, Mass.

It will be seen, therefore, that there is a marked improvement in strength, due to machine mixing, and as the machine is positive we can be assured of obtaining this concrete uniform, whereas with hand work it is likely to be anything but uniform, while a little carelessness makes a big difference in the final strength.

A series of specimens were made 1 ft. square, 6 ft. long, machine mixed, identical in every way except in the amount of cement used. There were two specimens each, 1—3—6, 1—4—8, 1—5—10, 1—6—12, 1—7—13. The results of each pair were averaged and are shown in the accompanying diagram. While these tests are not extensive enough to be conclusive they indicate that the strength is directly proportional to the amount of cement used. Be careful to note the difference between the ratio of *parts* of cement to *parts* of stone and the ratio of *volume* of cement to *volume* of concrete. With rich mixtures there is a very great difference. In the table given later the strengths of rich mixtures are all from actual tests while a few of the lean ones are interpolated from the diagram in which it will be seen that the lean mixtures most nearly agree with the average line. If a similar diagram be made for the rich mixtures in the table it will be noted that they are also proportional in strength to the amount of cement used. The results can also be expressed mathematically.

Taking the common formula for a straight line

$y = mx - b$ in which

ordinate $y = \dfrac{\text{volume of cement}}{\text{volume of concrete}}$

abscissa x = ultimate strength of concrete in pounds per sq. in.

m = slope of line whose intercept on the Y axis is b.

From the diagram we obtain

$$y = .00011x + .03.$$

$$x = 9091y + 273$$

During the construction of the Boston subway the engineers got better results from briquettes made from mortar taken from hand mixed concrete on the job than from that mixed in the laboratory, which would indicate that if laboratory tests are satisfactory, work properly done by hand on the job is bound to be. During the past season, when there has been such great activity in all lines of industry that there has been a great demand for labor, it has been difficult to keep laborers on jobs where concrete was hand mixed on account of this class of work being harder than other forms of concrete work. At the same time the laborers appeared to be more ignorant than of old as to how to mix by hand. Table I is an exact copy of a table used for many years in the writer's practice showing proportions and corresponding strengths for concrete as taken from actual tests from reliable sources.

The costs in the table are based on the following constants:

Cement (vol. 3.8 c. f.) delivered on job, per bbl. net....................$1.75
Broken stone (21 c. f. = 1 ton), per ton 1.50
Sand, per cu. yd..................... 1.20
Gravel (containing stone and sand in right prop), per cu. yd............ 1.15
Labor (foreman, common and misc.), .06 c. f. on per cu. yd.............. 1.62

In the selection of sand care should be used to avoid that which is fine and not sharp. The difference in strength due to these qualities alone in some tests of the writer's on sand that was used in foundations amounted to a loss of 52 per cent from standard sand. Dirt should also be avoided. There has been some controversy as to how much can be permitted, but the writer believes that the ordinary test which is performed on the work of throwing a handful into a glass of water is sufficiently reliable for all cases. When the water is badly muddied and remains clouded for a considerable time the sand should be washed or rejected.

There is little difference obtained in results of broken stone or gravel. By actual test the writer has found that a broken stone having a rough surface with angular fractures will give an increase in strength over a rough bank gravel of about 15 per cent in most cases. In some, however, the gravel has given the greatest strength. If the stone has a glossy surface much as is found with some trap rocks the gravel will always give the greatest strength. In the first instance if the specifications required "1—3—6" broken stone concrete and there is a difference in cost between broken stone and gravel screenings of $.02 per cu. ft. it will be cheaper to use a mixture of 1—2½—5 with gravel and still obtain an equal strength with the broken stone. The writer makes the rule never to allow the size of stone in its greatest dimension to be more than half the thickness of the work into which the concrete is to be placed. In large size work, very much larger stone can be used than is ordinarily done with very good results, the only limitation being that of convenience in handling. In regard to placing, it is much easier to obtain dense concrete, that is, without voids, using gravel than using broken stone, as angular pieces will sometimes arch together allowing a void to form underneath. Therefore, for watertight work gravel is to be preferred every time. For nearly all classes of work the best results will be obtained by using such an amount of water that the concrete when placed will just barely quake, but is not sufficiently soft to flow. The leanest mixture the writer ever uses is 1—4—8. In heavy bridge abutments where mass rather than great strength is wanted, with thorough mixing and careful placing still leaner mixtures might be used with safety. By reference to the table it will be seen that only 1 ct. per cu. ft. will be saved by using a mixture of 1—5—10 and the owner ought to pay this difference as insurance against the carelessness which is apt to occur on this class of work. In building construction where no restrictions exist the writer's standard mixture is 1—3—6 for every part of structure. In 14 years of practice this has had some severe tests without failure. In one floor built 11 years ago and which has been frequently overloaded ever since, there has been a number of minor failures because the foreman contrary to orders mixed one floor 1—3½—7. This would appear then to be the limit of leanness. Mixtures of 1—2½—5 and 1—2—4 are often used but are unnecessary in ordinary cases. Where a floor or column will be loaded in two to three weeks or is subject to vibration the richer mixture is desirable. A mixture richer than 1—2—4 is never necessary except in heavily loaded columns whose size is limited. Cement is the cheapest and easiest

TABLE I.—PROPERTIES OF CONCRETE.

Ratio volume of Cement Sand Stone	Volume of a batch in place, in cu. ft.	Barrels of cement per cubic yard.	Cost of cu. ft. broken stone concrete.	Cost of cu. ft. gravel concrete.	Ult. comps. stress broken stone concrete cubes 1 mo. old in pounds per sq. in.	Average ultimate crushing strength in pounds per sq. in. brickwork.	Cost per cubic foot of brickwork.
1—½—1	6.8	3.97	$0.37	$0.34	5540		
1—1—2	9.7	2.79	.314	.274	4000		
1 1½—3	12.6	2.14	.283	.237	3200	835	$ .44 First-class in cement mortar.
1—2—4	15.6	1.73	.264	.214	2700		
1—2½—5	19.0	1.42	.246	.195	2300		
1—3—6	22.8	1.18	.23	.179	2000		
1 3½—7	26.6	1.02	.219	.169	1785	486	.35 Good brick in cement.
1—4—8	30.4	.89	.210	.160	1625		
1—4½—9	34.2	.79	.205	.154	1500		
1—5—10	38.0	.71	.200	.149	1400		
1—5½—11	41.8	.65	.195	.145	1320	347	.26 Ordinary work
1—6—12	45.6	.59	.192	.141	1250		

form of reinforcement. The writer has used in columns one part of cement to one part of graded stone without any sand for a working load of 1,200 lbs. per sq. in. When this is done care must be used to continue this mixture through the thickness of floor, which will have a leaner mix.

Mixers are of two general types, the continuous and the batch. The continuous can be divided into those with and those without power. Without power the principal machines are the Portable Gravity and the Haines mixer, which is a series of conical hoppers supported one above another. The principle of both of these is identical; a concave inclined surface with pins inclined relatively to this surface of the machine. Those with power are of the trough type and have various means for mixing, such as screw, paddle blades, or revolving trough or drum with blades attached to side. The difficulty of good work with all this class of mixers is in combining materials before feeding into the machine. If they are not properly combined in the right proportions before feeding it cannot be done afterwards. There are various types of automatic feed to overcome this trouble but they are not all positive and require constant attention. These machines are not much used now, due chiefly to this uncertainty and in part because they are not as economical to operate as a good batch mixer.

Batch mixers are almost universally used because their mixing is positive. They can be obtained in the form of cubes, cylinders, and double cones. All give good results because all material in each charge is thoroughly mixed together, the difference in operation of the various machines being in the case of discharging and the wear and tear of the machine parts. The writer has used the Chicago cube, the Ransome and McKelvey cylindrical, and the Smith double cone machines, and prefers the latter to any other because of its very quick and clean discharge and because the wear and tear is small. With the batch mixer it is entirely unnecessary to dry mix before wet mixing. It is also somewhat difficult because the water remaining from one batch will interfere with the dry mixing of the next. The best method to follow when the whole batch is not dumped into the machine at once from a measure is to add water first, then stone, these scour out the mixer so that it always runs clean, then cement, and sand last.

The question is sometimes asked, when to use a mixer. The answer is, when the cost of setting up, taking down, and transportation equals the difference in cost of mixing by hand and by machine. It has been the writer's experience that under ordinary conditions concrete can be measured and mixed by hand for $1.30 per cu. yd. and by machine for $.85 per cu. yd. for the simplest method of setting up. The difference between these, $.45, times the number of yards to be mixed, will give the saving to be used in paying the general expenses of setting up a mixer, which for teaming a distance of three or four miles, setting up, dismantling and returning, together with allowance for wear and tear, amounts to $70. The cost of operating is included in the above cost of mixing. It will thus be seen that a job using 155 yards will be as cheap machine mixed as by hand, and of course any larger job should invariably be mixed by machine. The size to use should be determined by the size of the job and the amount which must be placed in one day. It is always best, however, to err on the safe side by having too large a machine rather than too small a one. Have one that is capable of mixing the day's work in three-quarters of a working day, allowing three minutes for mixing a batch and assuming a barrel of cement to contain 3.8 cu. ft., which equals 100 lbs. per cu. ft., and is now becoming quite general.

The greatest problem of operating a mixer is that of feeding and removing concrete. A mixer of the proper size will always mix faster than this can be accomplished. The simplest way of feeding which is suitable for small jobs is to build a wheelbarrow run to the feeding hopper and dump directly in. The hoppers which are attached to machines of some makes which lie on the ground and are filled by wheelbarrows and then lifted by the power that drives the mixer and dump into the machines are very convenient and economical ways for handling concrete on small jobs, and reduces the cost somewhat from the first method named. For large installations more economical methods should be obtained. Local conditions have such an influence upon the arrangement of plant that no general rule can be given. On a job the writer had the past year where over 125 cu. yds. had to be handled every day and where there was no room for storage on the ground local conditions determined the following method. The job was situated between two buildings. There was a canal between them in which the concrete was placed. On one side there was just room enough for a railroad track, on the other there was a width of 25 ft. To handle materials elevated bins holding about 50 tons of stone and 30 tons of sand were built high enough so that the aggregates were drawn through spouts into a measuring box, stone in front, sand behind. This was pivoted to tilt and dump directly into the mixer, which in turn was raised high enough for tram cars on rails to run underneath and receive the discharge, a 4-bag batch at a time. Two derricks were erected on the edge of the canal with booms long enough to reach across. Skips were set into the freight cars, filled by hand and swung by the derricks and dumped into the elevated bins. This method proved very satisfactory and economical. Fifteen freight cars were unloaded daily. After one was unloaded it was pulled ahead by block and tackle by the hoisting engine and replaced by another. The derricks commanded three cars at a time. By this means the cost of unloading cars and measuring and mixing was $.338 per cu. yd. and the cost of the installation, maintenance, dismantling and rental, which handled 3,410 yards was $1,571.93, or $.461 per cu. yd. In isolated places where crushers have had to be erected we have erected elevated bins with bucket elevator and rotary screen high enough to draw materials into measuring hopper and discharge directly into the mixer, and found the cost of mixing to be $.346 per cu. yd. and the installation to amount to from $1.98 per cu. yd. for a small volume of concrete to $.61 per cu. yd. for a large volume. Where conditions require cars to be unloaded onto the ground or where teams can dump close to the mixer a very convenient way is to set a measuring hopper flush with the surface of the ground, dig a hole into which the mixer is set so that the hopper dumps directly into it and set the elevator which handles the material into a building low enough to receive the discharge from the mixer. This set-up is inconvenient if the concrete is not to be lifted to a considerable height, as in building work. For feeding a mixer in this way the two-wheel barrows holding 6 cu. ft. will be found very convenient and economical to use, because it handles a considerable volume at one time and a man can handle 6 cu. ft. in this way as easily as 2 cu. ft. with a Pan-American barrow.

The above methods, though briefly described, may throw some light upon handling concrete. The economy with which concrete may be mixed depends upon handling it in large masses without the requirement of much labor. It is possible, however, as the writer has learned by experience, to spend so much in the installation of an economical mechanical plant that the incidental costs of installation offset the saving in the cost of the mixing of a comparatively small volume of concrete over the cost of a very simple set up, with higher labor cost of operating. Therefore trained judgment is always the best guide in the long run.

The British India Government is considering a scheme to link the five rivers—the Indus, Jelum, Chenab, Beas, Ravi and Sutlej—together in such manner as to equalize the flow of water when one river or more is in flood and thus supply the whole canal system connected with these rivers.

The Building Law Committee of the Board of Supervisors of San Francisco, Cal., has decided to recommend that the laws require that all sewer connections be made ratproof by the use of an iron hub or concrete wherever pipes run through floors or walls.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Estimated Cost of the Ashokan Reservoir and Data of Actual Cost of Similar Earth Embankments, Together with a Discussion of the Testimony Submitted in the Investigation of the Ashokan Dam Award.

(Concluded from last week's issue.)

The Board of Advisory Engineers gathered much information regarding reservoirs being constructed by the U. S. Reclamation Service. These data will, no doubt, be of value to other engineers and so are presented here. There are four earthen dams on this Reclamaiton Service work comparable to Ashokan. One is in South Dakota, two are in Idaho, and one in Eastern Oregon. The information regarding the dams was secured at the office of the Reclamation Service, Washington, D. C., from official records and from officers of the service.

THE BELLE FOURCHE DAM.

The Belle Fourche Dam is an earth dam with a maximum height of 115 ft. and top length of about 6,500 ft. built across Owl Creek in South Dakota. The estimated amount of excavation for the embankment is 1,580,000 cu. yds., and it is about 30% completed. The dam has no core wall.

Bids for this work were opened Oct. 16, 1905. The lowest bid, that of Orman & Crook, of Pueblo, Colo., was accepted and work is now in progress. The price bid for "Earth Excavation for Embankment" was 28 cts. This includes excavation, transportation, depositing, spreading into 6-in. layers, wetting and rolling. The measurement for payment is of material excavated in place.

The material of which the dam is built is adobe clay or gumbo soil, very heavy, with occasional layers of sand and shale and scattering cobble stones. The specifications require the removal of all stones exceeding 6 ins. in diameter.

Allowing 10% for shrinkage this contract price of 28 cts. for excavation would make an embankment cost of 30.8 cts. per cu. yd. The material is hard adobe clay which shrinks comparatively little. It is taken from borrow pits at each end of dam and some from within the reservoir. The average haul is a little less than a mile, practically the same as at Ashokan. The material is compacted into 6-in. layers by spreading, wetting, tamping and rolling. All trench excavation, excavation for structures, for stripping borrow and gravel pits, and for trimming the embankment are paid for extra. The fact that Owl Creek runs dry in the summer has necessitated the contractor building two reservoirs, one at each end of the dam, for the storage of water for earth compaction. This is done at his own expense and it is distributed over the dam by an elaborate series of pipes and hose. This water and all used for compaction has to be pumped up from Owl Creek, and, as in this dry country the rate of evaporation is high and the earth becomes very dry in summer, this water supply has involved a very considerable expense. The sprinkling is done with hose connected with an elaborate system of pipes laid on top of the dam. Any leaks in the pipe cause troublesome bogs, as the adobe clay absorbs water quickly. On the other hand when dry, it pulverizes easily, thus causing great clouds of dust on windy days, that neither man nor beast can stand. Although the work is not interferred with on account of rain, it has to be suspended during these wind storms. This dust also effects the horses and mules employed on the work, so that a number of them get a lung trouble from which they quickly die. The aridity increases the cost of sprinkling.

Another point of some importance is that the surface water is so bad for boilers that it was necessary for the contractor to put down an artesian well to get water for his steam shovels, locomotives, etc. The work is being done with two steam shovels and narrow gage cars and locomotives, and also with two New Era graders and about 24 dump wagons. A long time was lost during the past summer because of the water ruining the boilers.

The engineers of the Reclamation Service keep records as closely as possible of the cost of the work to the contractors, and according to these records the contractors are losing some money. According to the figures given the contractors, up to October 1, 1907, had earned for the regular dam excavation the sum of $115,195, while the cost to them had been $126,013. This cost to them is equivalent to 32.3 cts. per yd. or 35.5 cts. in embankment. On some other items they had made money and on some others had lost. The records show that on the whole work up to September 31, 1907, the contractors had lost about 6% of the amount earned, or $10,816.

At this Belle Fourche Dam laborers receive $2.60 per 8-hour day; foremen and blacksmiths, $4.00 per day; and steam shovelmen, $6.00 per day; teamsters with teams, about $4.50 per day, and bare teams $50.00 per month. Coal for steam has to be hauled 12 miles over bad roads and costs $8.70 per ton on the work. Hay and feed for animals and all supplies have also to be hauled this 12 miles and are expensive in consequence. The work has to be closed down for about four months during the winter.

PAYETTE-BOISE PROJECT.

The Payette-Boise project requires two earth dams, which are called Upper and Lower Deer Flat Embankments. These are for the storage of water from the Boise River, Idaho. The body of each dam is of earth and gravel; for the up-stream face a material is required containing 30% of clay, and for the down-stream face a clean coarse natural gravel is required. The upper embankment has a height of about 75 ft. and the lower of 50 ft.

Bids for this work were opened February 1, 1906. All bids for the upper embankment were considered too high and were rejected. The lowest bid was 36 cts. per cu. yd. for excavation for embankment. This would be equivalent to about 39½ cts. on embankment as measured at Ashokan.

The contract for the lower embankment involving 950,000 cu. yds. was let to Hubbard & Carlson of Boise at a price of 24 cts. per cu. yd. for the main structure and 35 cts. for the face and back work, an average price, according to the estimated quantities of 25.2 cts. per yd. Allowing a shrinkage of 10% to make the prices comparable to the Ashokan prices, the contract price in embankment would average 27.7 cts. per yd.

The work is being done with steam shovels on the hill, transportation by cars, and by scrapers from within the reservoir site. The 8-hour day prevails. Work has to be suspended in winter for about four months. Labor is $2.00 to $2.50, averaging $2.25 per day, and is hard to get. Coal costs about $7.50 per ton on the work. At the contract price named the contractors are making money.

The following regarding the work is from a report to the director of the Reclamation Service by an engineer inspector in the service during the past autumn:

LOWER DEER FLAT EMBANKMENT PAYETTE-BOISE PROJECT.

"Hubbard & Carlson.—This work provides for the construction of lower Deer Flat embankment. The volume of work done to date is $253,273, on which there has been a profit of $73,635. Plant depreciation, however, has not been deducted, so this amount will be materially reduced on the final cost sheets. The management of this contract has been excellent and has showed a handsome profit from the beginning. The unit prices were thought by some contractors to be low, but a profit has been realized on practically every item. The date set for the completion of this contract is October 1, 1907, and it will be completed by January 1."

The work is about 97% done.

It is evident from this statement and

from the monthly reports of the engineers that, excluding the item of plant depreciation, the work is costing the contractors about 18 cts. per cu. yd. in excavation, or about 20 cts. in embankment and that they are making a profit of about 33⅓% at their contract price.

The Upper Deer Flat embankment of the Payette-Boise project, for which all bids were rejected, is being done by hired labor. It is quite similar in its main features to the lower embankment, with, however, a little shorter haul. The embankment will contain about 1,000,000 cu. yds. It is being done by steam shovels and cars. A careful account is kept by the Reclamation Service engineers of the cost of the work, and, up to date, it is found that the cost of excavation for embankment is 19½ cts. per cu. yd. including supplies, excavation, transportation, dumping, spreading, wetting and rolling, but no allowance for plant and depreciation. Allowing 10% for shrinkage this would make the embankment cost about 21½ cts. per cu. yd. To this must be added about 6 cts. for plant and depreciation, making the total cost of the embankment 27½ cts. per cu. yd. The engineers state that they expect to get the average cost for the work down from 19½ cts. to 16 cts. for excavation equivalent to 18 cts. for embankment. In fact the record for the month of November shows a unit cost for the excavation of 16.5 cts. per cu. yd.

From the last monthly report of operations on the work the following figures of cost are taken:

For the work to date the cost has been as follows per cu. yd. in excavation:

Engineering	$0.004
Superintendence	0.006
Clearing	0.001
Protection of property, day	0.001
Protection of property and night work	0.005
Steam shovel work	0.055
Hauling by cars	0.077
Spreading	0.019
Sprinkling	0.019
Compacting	0.011
Total	$0.198

For the operations during the month of November these items were as follows:

Engineering	$0.004
Superintendence	0.006
Clearing	0.001
Protection of property, day	0.001
Protection of property and night work	0.005
Steam shovel work	0.049
Hauling by cars	0.067
Spreading	0.014
Sprinkling	0.010
Compacting	0.008
Total	$0.165

UMATILLA PROJECT.

The Umatilla Project in Oregon involves the building of an earth dam containing 613,000 cu. yds. Bids for this work were opened on June 28, 1906, and two bids were received. One bidder offered to do the earth excavation for embankment at 31 cts. per yd., and the gravel for 45 cts. The other bid was 41.85 cts. for both classes of work. The engineers estimate for both classes of work was 30 cts. per yd., equivalent to 36 cts. in embankment. The bids were considered excessive and all were rejected and the work is being done by day labor. About 57% of the work has been done and an accurate account of its cost has been kept. From a statement showing the cost of the work up to Nov. 30, 1907, it is seen that the cost of the earth excavation for embankment is 26.6 cts. per cu. yd. and of the gravel is 35.2 cts. This includes a charge for the plant and its depreciation. The gravel is procured in one place, and the clayey earth in another, and the two are brought to the site and deposited in the variable proportions required for the different portions of the dam, spreading it in thin layers by road scrapers and then artificially mixing it by thoroughly harrowing it with disc or wheel harrows, and then wetting and rolling it in 6-in. layers. So thorough is the mixing and compaction that the material in the embankment occupies less than 80% of the space embraced in its excavation, there being a shrinkage of over 20%. Allowing for the shrinkage of 20% the average cost of embankment per cubic yard is about 36 cts., if the unit cost as above given is maintained to the end. One reason for the increased cost of this work over that on the Upper Deer Flat Dam of the Payette-Boise project, also being done by hired labor, is that the material of which the embankment is composed has to be brought from separate places, artificially mixed, and in variable proportions depending on its position in the dam.

This work is being done chiefly by steam shovels and cars. The work is in an isolated portion of Oregon where labor and fuel are high, laborers being paid $2.40 for an 8-hour day, and coal costs $8.63 per ton.

The work at Ashokan is one of great simplicity and only remarkable for its great magnitude. There is certainly nothing complicated or mysterious about the earth work. The operations to be gone through in excavating the channels and trenches and making embankments are those in common use all over the country, and with which thousands of men are familiar. The engineers of the Board of Water Supply in their testimony spoke of the difficulties to be overcome in this "hydraulic work," and alluded to the hard material to be excavated, as well as the material for the embankments having to be selected with great care. On this subject the Advisory Board of Engineers, in their report, had the following to say:

"We have called the conditions favorable, and, so far as the magnitude of the work and the proximity of suitable material for embankments are concerned there can be no question as to favorable conditions. But, as to the toughness of the earth and the percentage of cobbles and boulders in it, there is no doubt that honest difference of opinion may exist. The engineers of the Board of Water Supply have sunk three deep shafts, to ascertain the character of the earth, and it is noteworthy that they have repeatedly used the word "hardpan" on the drawings that denote the character of the material in these shafts. The same word, "hardpan," is also used in the specifications (Section 3) in reference to the foundations upon which core walls may rest. There is no doubt that the greater part of the material to be used in the embankments was regarded by the engineers of the Board of Water Supply as being "hardpan," and exceedingly difficult to excavate. Since they made no extensive open cuts to determine the difficulty of digging the earth, their only criterion was the difficulty of sinking the deep shafts, and drilling holes in the ground, and the appearance of the earth where exposed to the air by one agent or another. It is important to bear this fact in mind, for it undoubtedly operated to lead the engineers into making a high estimate of cost, and thus influenced the contractors who found that the engineers had labeled all the test shafts as being mostly in "hardpan."

"In digging a shaft a laborer is always working at great disadvantage. Each chunk of earth or stone which he loosens with his pick is ordinarily bound in on four sides by the surrounding earth. The difficulty of loosening earth in the bottom of a shaft is often several times greater than when working to a vertical face in an open cut. The shoveling is also much more difficult in shaft work. It is not surprising, therefore, that, to anyone who did not give due weight to these facts, the material excavated in these shafts seemed like "hardpan." To this board, who had not seen the label "hardpan" on the diagrams of the shafts until they had completed their field inspection, it never once occurred that any one would have classed the material as "hardpan," excepting in a few isolated spots. In proof conclusive that the clay and scattering cobble stones is not hardpan, this board is able to cite several facts.

"The contractors are now engaged in grading a line for a railway on the reservoir site, and, during the two days this board was on the ground, there were four places where excavation was in progress. In the heaviest cut a two-mule plow team was plowing a material that is partly clay and partly gravel, and the loading of this material into wagons with hand shovels was going on at a rate that indicated no great difficulty. Certainly that "cut" was not in hardpan, for it usually takes a 6-mule plow to make any headway in true hardpan.

In the next two "cuts" men with picks and shovels were loading carts, there being 3 or 4 men with picks to 4 or 5 men with shovels. This was hard digging, due to roots and small cobblestones which impeded the work of both picks and shovels, but it was not hardpan in any sense of the term. On one of these cuts the foreman used about 2 cts. worth of dynamite per cu. yd. to loosen the material, and thus cut down the number of men with picks.

"On the last cut, members of this board kept track of the progress made by 8 men picking and shoveling into carts, no explosives being used, and found that in 9 hours time they loosened and loaded 12 cu. yds. per man. The material was clay containing cobbles and a few scattering boulders, and was not "soil." It was, in fact, as nearly typical of the material that has been excavated from the deep test shafts as anything that was seen by this board. When it is remembered that the word "hardpan" is not properly applied to earth until it is of such toughness that less than about 4 cu. yds. are loosened and loaded per man per day, it is clear that the material in this cut was not hardpan.

"In brief, it is the opinion of this board that no extensive deposits of true hardpan exist on this work, and, if they should be discovered, the barrow pits can be shifted so as to avoid them. It is probable that the contractors will use explosives to loosen the clay in advance of the steam shovel work, not because it will be necessary, but because the output of a steam shovel can be sufficiently increased by the expenditure of a cent or two per cubic yard for the blasting to warrant using explosives. This 'boulder clay' in no sense resembles the 'boulder clay' on the Chicago Drainage canal.

"The engineers of the Board of Water Supply have wisely spent more than $100,000 exploring the site of the dams and quarries with diamond drills and wash borings. They have also spent more than $40,000 sinking three deep shafts on the site of proposed dikes, and several shallow shafts and test pits on the site of proposed sand pits. All this exploration, excellent as it was for its purpose, fails to disclose the ease or difficulty of excavating the earth with steam shovels or even with hand shovels in open cuts. By far the major portion of this exploration is valueless to a contractor or engineer in estimation costs of excavation, although it serves admirably in designing the masonry and earth structures and in estimating the probable quantities. It is noteworthy that the engineers of the Board of Water Supply sank no test shafts, and dug no test pits, either on the sites of the proposed barrow pits or on the site of the east and west channel—the very places that are intended to supply practically all the material for the earth embankments. The only guide as to the nature of materials to be encountered in these barrow pits and channels was a few core and wash drill holes. These do not serve to indicate the ease or difficulty of excavation. This board is able to judge far better, by the open cut excavation now being done by the contractors, as to the toughness of the earth, than by all the exploration made by the engineers of Board of Water Supply."

The Board of Advisory Engineers were also informed by the engineers of the Board of Water Supply that no tests were made to find the per cent of excluded cobbles that would be found in the material from which the embankments were to be made, nor the amount of water needed to compact the material, nor what shrinkage could be expected in the material. All of these are factors that enter into making a close estimate on the cost of the work.

Mr. Otto H. Klein, of the Advisory Board of Engineers, is chief engineer of the Commissioners of Accounts, and it was upon his recommendation that the investigation was made.

Lt. Col. Thos. W. Symons, of the United States Army Corps of Engineers, was the second member of the Advisory Board. Col. Symons has for 33 years been engaged in engineering and constructing work, of road building, river and harbor improvements, building break water, jetties, light houses, canals, and docks. He designed and built the breakwaters at Buffalo. He designed and built a reservoir at Washington, D. C., and is at present engaged as consulting and superintending engineer for the new water works of Buffalo, N. Y. He is also consulting engineer for the Barge Canal of the state of New York.

The third member of the board is Mr. Halbert P. Gillette, managing editor of Engineering-Contracting. Mr. Gillette has for 16 years been active in the engineering field, designing and building structures of all kinds. His work has included constructing railroads, water works, bridges, canals and river improvements, both as an engineer and as a contractor. On all work he has kept detailed costs, and has made a study of methods and cost of doing work. He has written four books, namely: "The Economics of Road Construction," "Earthwork and Its Cost," "Rock Excavation, Methods and Cost," and "A Handbook of Cost Data." As associate editor of Engineering News and managing editor of Engineering-Contracting he has visited most of the largest dams of the country to study the methods and costs of doing this class of work. Mr. Gillette is also the chief engineer of the Washington Railroad Commission, having appraised the value of the railways in that state, amounting to a quarter of a billion dollars, and on that work has secured the actual cost in detail of all structures on 3,300 miles of railroad.

The fourth member of the board was Mr. D. J. Hauer, associate editor of Engineering-Contracting. For 19 years Mr. Hauer has been engaged in constructing work both as an engineer and contractor, having built railroads, wagon roads, canals, reservoirs and dams, buildings, piers and docks, sewers and many other kinds of structures. He has operated steam shovels, and other excavating machinery, and has kept a cost data in detail, having analyzed such data for the purpose of developing systems of doing work economically and for publication. Beside these four engineers of the Board of Advisory Engineers, there were five other engineers called in as consultants.

The first consulting engineer to be called was Mr. Chauncey Ives, who for many years has been in charge of heavy construction work, including railroads and wagon roads. Mr. Ives has for some years been connected with the Pennsylvania R. R. in connection with heavy earth and rock grading on various parts of their system. He has had much to do with steam shovel work, and has numerous records of cost of using steam shovels for excavation. In his report he prepared a cost analysis of the earth work at Ashokan in great detail, showing a handsome profit at the bid prices of the John Pierce Co.

Another of the consulting engineers was Mr. Edward Wegmann, the well known author of the treatise on "The Design and Construction of Dams," which is considered the authority on the subject. Mr. Wegmann is also the author of "The Water Supply of the City of New York, 1658-1895." His experience in engineering work reaches over a period of 36 years. He has been engaged in railroad, bridge and water work construction, besides having had experience in rolling mills and locomotive works. Since 1884, for a period of nearly 25 years, he has been connected with the Aqueduct Commission of New York City, and is at present a consulting engineer for them. In this connection he has built reservoirs and aqueducts, and he has made an exhaustive study of dam and reservoir construction, which has been embodied in his books.

Major Cassius E. Gillette, another of the consulting engineers, is a graduate of West Point, and served for 22 years (until 1906) in the Corps of Engineers of the U. S. Army, building locks, dams, levees, embankments, jetties, breakwaters, training walls, spur dikes, fortifications and many other works that included excavation of earth and rock. During 1906 and 1907 Major Gillette was chief engineer of the Bureau of Filtration in Philadelphia, this work covering filters, pumping stations, pipe lines and reservoirs.

Mr. R. W. Creuzbauer, another of the consultants, has been engaged in engineering work in Philadelphia and New York for many years, being the consulting engineer of the Borough President of Brooklyn, New York. He has made a study of, and has done much, municipal engineering, and in his present position he passes upon numerous important contracts of this nature.

Mr. A. P. Davis, the last of the five consultants, has been engaged in engineering work for 25 years. Since 1888 he has been with the "Irrigation Survey of the U. S. Government," now known as the

Reclamation Service, being at the present time its chief engineer. Under Mr. Davis there are 1,200 engineers at work. Numerous reservoirs and irrigation canals have been built by the "Service," there having been expended to date $33,000,000. The principal construction work performed to date is as follows:

Large canals constructed, miles	1,815
56 tunnels, aggregating miles	11
Large structures completed	214
Small structures completed	670
Wagon road built, miles	611
Telephone lines built and operating, miles	830
Electric light plants built and operating	5
Cement manufactured, barrels	85,000
Lumber manufactured, ft. B. M.	3,036,000
Borings made, ft.	66,749
Transit lines run, miles	18,900
Level lines run, miles	24,218
Detail topographic surveys, sq. in.	10,970
Earth excavation, cu. yds	33,419,222
Rock excavation, cu. yds	4,745,000

Most of this work has been done under contract; but for several years the Reclamation Service has been unable to get satisfactory contractors, owing to the fact that contractors have been busy; and, as much of the work is inaccessible, the hazards of labor shortage and freight congestion have deterred contractors from bidding. This has made it necessary to do some of the work by day labor.

The reclamation service has in use an elaborate system of cost keeping for both contract and day labor work, and Mr. Davis has access to this vast collection of cost data.

These nine engineers (the four on the Board of Advisory Engineers and the five consultants) were unanimous in their opinion that the bid of John Pierce Co. would have yielded a fair profit.

The accompanying table shows bids submitted at the letting of the Ashokan dam contract. The last column is the estimate of the chief engineer, Mr. J. Waldo Smith.

Under earth excavation, Class A includes earth from trenches less than 20 ft. deep and 20 ft. wide, such as core wall trenches. Class B is for the same trenches when they are carried down deeper than 20 ft. Class C is earth excavated from the dam site, the gate chamber, the inlet chamber, for the aqueducts, and for the waste and dividing weirs. This is the large class, and is mostly steam shovel work. Class D is soil stripping.

Class A of embankment work is to go on the upstream side of the dam and be compacted in 4 in. layers, while Class B is for the downstream side, compacted in 6 in. layers.

All stones of such size as interfere with the compacting must be excluded. These stones go to make up Class C of embankment, and are to be deposited on the upstream face of the embankment. Class D is soil placed on the down stream face of the dike.

These are the items of earthwork. The material to be excavated consists in general of a glacial deposit, or till, comprising clay, sand, gravel and some boulders, standing up well under excavation, and being practically impervious to water. This material covers substantially the entire zone of operations and as far as can be determined in advance will be encountered in the barrow pits and excavations.

The rock in this locality is a bluish gray sandstone, interstratified with shale, and is commercially known as blue stone. It belongs to the Hamilton Flags and related sandstone formations. It is easily excavated and quarried.

As a result of their "hearing," the Commissioners of Accounts made a report to Mayor McClellan, stating that the members of the Board of Water Supply had been guilty of incompetence and had been grossly careless in performing their duties as city officials, and that they would prefer charges against them in a subsequent communication to the mayor. The mayor referred the whole matter to the Corporation Counsel, who, in a letter to the mayor, stated that the actions of the Board of Water Supply had been legal; and he recommended that charges should not be made against them, as they had acted on their best judgment. This prevented any further action by the mayor in the matter.

Canvas of Bids opened Aug. 6, 1907, by the Board of Water Supply of New York City, for Contract No. 3, Main Dams, Ashokan Reservoir.

				BIDS					Estimate of J. Waldo Smith, Ch. Eng.
				John Pierce Co.	McArthur Bros. Co. and Winston & Co.	Bradley Contracting Co.	Stewart, Kerbaugh, Shanley Co.	O'Rourke Engineering and Construction Co.	
Item	Description.	Unit.	Quantity	Price	Price	Price	Price	Price	Price
1	Removing Steel Pipes	Lump Sum							
2	Control of Steam Flow, Olive Bridge Dam	" "							
3	" " " " Middle Dike	" "							
4	Earth Excavation, Class A	Cubic Yards	95,000	$0.60	$1.40	$0.60	$0.45	$1.50	$1.25
5	" " " B	" "	50,000	1.00	2.50	1.50	2 00	3 00	2.25
6	" " " C	" "	1,700,000	.30	.68	1.00	.52	.75	.50
7	" " " D	" "	210,000	.35	.50	.50	1.00	1.50	.50
8	Rock Excavation, Class A	" "	140,000	2.50	3 00	3.10	3.00	5 00	3.50
9	" " " B	" "	210,000	1.50	1.60	1.75	1.00	1.75	1.50
10	" " " C	" "	75,000	1.25	1.00	1.75	2 00	1.75	1.50
11	Special Preparation of Rock Surfaces	Square Yards	40,000	1.00	.50	2.00	.80	.50	.60
12	Embanking and Refilling, Class A	Cubic Yards	2,500,000	.42	.60	.60	.64	.60	.67
13	" " " " B	" "	3,200,000	.375	.60	.65	.64	.58	.50
14	" " " " C	" "	1,200,000	.35	.50	.75	.80	.95	.70
15	" " " " D	" "	110,000	.50	.50	.55	.80	1.50	.50
16	" " " " E	" "	45,000	.50	.50	.50	.75	.50	.50
17	Soil for Surface Dressing	" "	210,000	.40	.50	1.25	1.50	1.00	.80
18	Portland Cement	Barrels	1,100,000	1.90	1.50	2.10	1.53	2 00	1.90
19	Concrete Masonry	Cubic Yards	280,000	4.25	4.90	4.00	5.60	5.50	5 00
20	Cyclopean Masonry, Class A	" "	475,000	3.00	3.40	3.00	4.10	3.30	3 20
21	" " " B	" "	55,000	3 00	3.90	3.50	5 05	3.10	3 40
22	Concrete Blocks	" "	64,000	8 50	11.50	7.50	9.20	8 50	8 60
23	Reinforced Concrete	" "	100	12.50	20 00	25.00	9.25	10.00	12.00
24	Masonry Filling Openings, control stream flow	" "	8,000	8 10	1.50	4.00	5.20	4.50	3.00
25	Grout of Portland Cement	" Feet	5,000	.30	.50	2.00	.25	.50	1 00
26	Drilling Small Holes in Rock or Masonry	Linear Feet	1,000	.50	1.00	1.00	.65	1.00	1 00
27	Face Dressing of Concrete	Square Feet	125,000	.15	.10	.50	40	.15	.25
28	Dry Rubble Paving	Cubic Yards	95,000	2.50	2 50	2.50	4.15	3 00	3 00
29	Rip-rap	" "	10,000	1.50	1.50	2.00	3.30	2.00	1.80
30	Cast Iron Pipes and Special Castings	Tons	75	90 00	101 00	100.00	140.00	120.00	66.00
31	Steel Castings	"	80	160 00	150.00	150.00	280.00	300 00	200.00
32	Steel for Reinforcing Concrete	Pounds	25,000	.06	.07	.05	.05	.06	.08
33	Wrought Iron, Cast Iron and Steel	"	590,000	.05	08	.05	.08	.15	.05
34	Bronze Work	"	4,000	.50	.50	1.00	.70	.50	.50
35	Furnishing and Placing Wrought Iron Pipes	Linear Feet	2,500	.40	.50	.50	.80	.50	.40
36	Caring for and Setting Metal Furnished by City	Pounds	900,000	.02	.02	.03	.02	04	02
37	Clearing	Acres	200	100 00	140.00	75.00	130.00	50 00	50 00
38	Vitrified Pipes not Exceeding 10" in Diam.	Linear Feet	115,000	1.50	.50	1 00	80	.50	.90
39	" " from 12" to 18" inclusive in Diam.	" "	100,000	3 00	1.25	1.50	1 50	1.00	1.50
40	Crushed Stone and Gravel	Cubic Yards	110,000	2.00	1.25	2 00	1.75	2.50	1.50
41	Timber and Lumber	M. Ft. B. M.	950	40 00	50 00	60.00	65 00	75.00	55.00
	Total			$10,315,350	$12,669,775	$13,931,250	$13,931,250	$14,747,750	$12,841,000

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Some Pile-Driving Experiments in Connection With the Construction of the Charles River Dam.*

BY J. ALBERT HOLMES, C. E.†

The work of building the Cambridge marginal conduit of the Charles River dam has begun on the Cambridge shore. Up to Jan. 1, 1907, 9,969 foundation piles had been driven in the Boston and Cambridge coffer-dams, amounting to 297,000 lin. ft. The average length of the piles under the lock after cutting off was 29 ft.; under the sluices, 31 ft. 4 ins. The specifications called for piles to be winter-cut from straight, live trees, not less than 10 ins. in diameter at the butt when cut off in the work, and not less than 6 ins. in diameter at the small end. A safe load of 12 tons per pile was assumed for the lock foundations and 7 tons per pile at the sluices.

The Wellington or "Engineering News" formula was used in determining the bearing power of the piles. This formula is described by the "Engineering News" as follows:

$$L = \frac{2wh}{s+1}$$

"In which L is the safe load in tons (using a factory of safety of 6); w is the weight of the hammer in tons; h is the fall of the hammer in feet, and s is the penetration or 'set' of the pile in inches, under the last blow of a free-falling hammer (not retarded by hammer rope) striking a pile having a sound head. If a friction clutch driver is used, so that the hammer is retarded by the rope attached to it, the penetration of the pile is commonly assumed to be just one-half what it would have been had no rope been attached, that is free falling. There have been too few experiments made to warrant any great reliance upon this last assumption."

The above formula is discussed by Foster Crowell, M. Am. Soc. C. E., in the Transactions of the American Society of Civil Engineers for December, 1899, Vol. XLII, page 278, as follows:

"What enables the descending ram to drive the pile is the energy stored therein, but not all of that energy is available for the purpose, half of it being required to maintain the movement of the ram. That which is available is known as the accumulated work, to be expended upon the sum of the resistances offered by the pile.

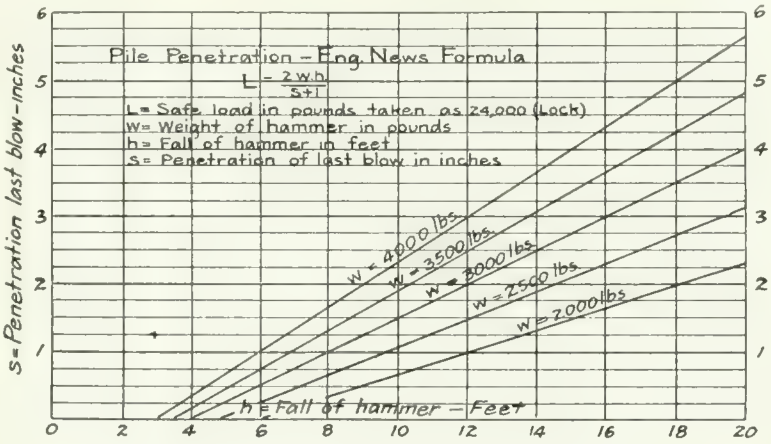


Fig. 1—Diagram Based on Wellington Formula.

"In the Wellington formula the principle of accumulated work is the basis; it is expressed in inch pounds, but as it contains a silent factor of safety of 6, and as for convenience h is given in feet, the accumlated work is written wh instead of $w\ 12\ h$. The denominator is the measure of resistance developed by the pile, as indicated by its penetration under the last blow, or settlement, s, also expressed in inch terms.

"Were it not for the presence of resistance in the pile-driving machine, and other causes tending to oppose the driving of the pile, s would be the full measure of the net resistance, and the quotient would be that resistance; but these various unmeasured opposing forces must be taken into consideration, and they are represented by the constant quantity, 1, in the denominator.

"Thus we have the derivation of the Wellington formula."

A diagram (Fig. 1), based on this formula, was furnished the pile-driving inspectors as a guide, and a record kept of the location, kind, length, and diameter of each pile, also elevation of butt as left, time consumed in driving, and number of blows required to drive last foot, and total penetration of pile.

A number of experiments were made in connection with the pile driving, one of which was the redriving of a pile in the lock foundation after a rest of fourteen and one-half hours.

The "set" (s) of this pile under the last blow of the original driving was 4 ins. This gave, using the formula, a safe load (L) of only 13,400 lbs., which was about half the load the piles under the lock were assumed to carry. It was desired to learn how much the bearing power of the pile increased after driving; after a rest of 14½ hours, the pile was redriven through a distance of 11¾ ins., the "set" (s) under the first blow of the redriving was 2¼ ins., giving for L 20,600 lbs.; under the last blow s was 2½ ins., giving for L 19,100 lbs.

TABLE I.—SHOWING RESULTS OF REDUCING TESTS IN FOUR PILES WHICH HAD RISEN AFTER DRIVING.

Number of Pile	Date of Driving.	Length of Pile.	Number Blows Last foot.	Fall of Hammer Last foot.	$\frac{2 w. h.}{S+1}$ w=2,785 lbs.	Rise of Piles to Jan. 9, 1906.	Re-driving Test of January 10, 1906. $\frac{2 w. h.}{S+1}$ First blow.	Penetration per Blow—inches. 1	2	3	4	5	6	7	8	9	10	$\frac{2 w. h.}{S+1}$ Last blow.	Total Penetration. Re-driving, Feet.
		ft.		ft.	Pounds.	feet.	Pounds.											Pounds.	
2139	Dec. 6, '05	35	12	8	22,000	0.27	26,000	1⅛	1⅜	1¼	1⅛	1	1½	1	1¼	1⅜	....	23,000	0 90
2140	"	34	11	8	21,000	0.34	26,000	1⅛	1	1¼	1	1¼	1⅛	1⅛	1⅛	1⅛	1⅛	26,000	0 93
2141	"	35	14	8	24,000	0 29	25,000	1¼	1¼	1¼	1¼	1⅛	1	1⅛	1⅛	1	1¼	26,000	0 96
2142	"	35	14	8	24,000	0.29	25,000	1¼	1⅛	1	2	3⅛	3	3	3½			12,000	1 50

NOTE.—Weight of hammer, 2,785 lbs; pull of hammer, 10 ft.

The piles under the lock walls were driven very close together, and as a result many of them rose during the driving of adjacent piles. Careful elevations were taken on a number of the first piles driven in a thickly piled area during the driving of the remainder of the piles, and four of the original piles which had risen redriven. The results of this redriving are given in Table I, and Fig. 2 is a sketch of the redriven piles.

---

†Division Engineer, Charles River Basin Commission, Boston, Mass.

*Abstracted from the "Harvard, Engineering Journal," November, 1907.

The inspectors' data give for the first pile in the table, $L = 22{,}000$ lbs. for the original driving. The pile had been driven a little over a month and had risen 0.27 ft.; the first blow of the redriving gave for L 26,000 lbs., and the last 23,000 lbs. During the redriving of these 4 piles the "set" was carefully measured for each blow, the fall of the hammer being uniformly 10 ft.

The last pile (No. 2142) acted in a peculiar manner during the latter part of the redriving. It will be noticed that the "set" (s) for the first blow was 1¾ ins., and L 25,000 lbs., while the last blow gave 3½ ins. "set" and L only 12,000 lbs., the spacing, center to center of piles, was 2 ft. by 2 ft. 6 ins.

Another experiment was made to determine whether or not a pile that had been driven for the lock foundation and had risen would settle back into its original position when loaded; the pile had been in the ground about one month and had risen 0.14 ft. during the driving of adjacent piles.

The inspectors' data gave 26,000 lbs. for L as originally driven. The pile was capped, a timber platform bolted to the caps, and a load consisting of pig lead gradually applied.

During a period of 17 hours a load of 9,400 lbs. produced no settlement; the load was increased to 17,400 lbs., and at the end of another period of 24 hours a settlement of 30,400 lbs. was then applied, and at the end of the next 24 hours the total settlement amounted to 0.015 ft., which gradually increased to 0.029 ft., 10 days after the first load was applied; this amount did not increase up to 25 days, at which time the whole load was removed and the pile found to have returned to the position it was in when the first load was put on.

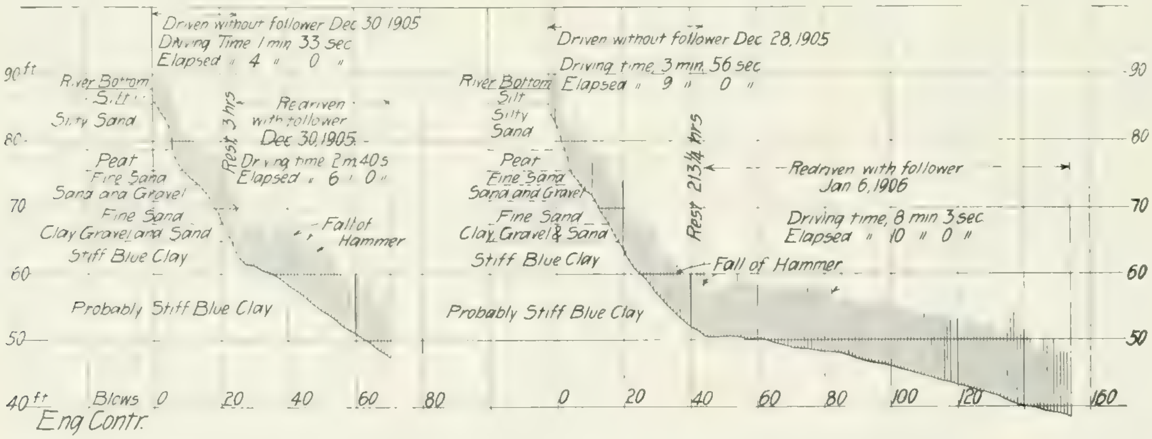


Fig. 3—Diagram Showing the Action of a Pair of Piles While Being Driven.

At the sluices in the Cambridge cofferdam 8 test piles were driven in pairs, the piles in each pair being about 3 ft. apart

The diagram (Fig. 3) shows the action of the piles in one pair while being driven. The geology of the river bottom through which the piles passed is given. The heavy line indicates the movement of the tip of the pile, and the resistance to driving is shown as it passes through the different strata; the length of the light vertical lines show the fall of the hammer, and the number of lines the number of blows. The weight of hammer and follower are given (the piles were driven from a floating machine, and a follower used while redriving), also the actual driving and redriving time and the elapsed or total time consumed.

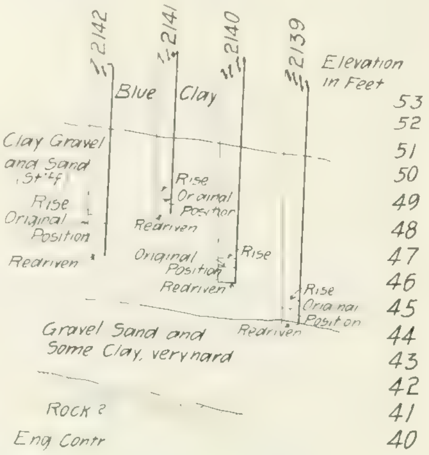


Fig. 2—Sketch of Re-driven Piles.

To obtain these data a party of five men was required. A scale was marked on the gins of the pile driver, and a tide gage set in a convenient position. One man called the reading on the scale at the beginning of the fall of the hammer; a second called the reading at the end of the fall, which also gave the elevation of the butt of the pile, from which that of the tip was determined; a third man recorded the readings of the first two; a fourth man was engaged with a stop-watch in keeping the actual driving time, while the fifth kept the total time, noted the rise or fall of the tide, the vertical movement of the scow, and checked the total movements.

It will be noticed that pile No. 5007 of this pair was redriven after a rest of only three hours, and that the tip finally reached an elevation only a little below that of the other pile in its original driving. While none of the 8 piles refused to start under the first blows of the redriving, a sharp break occurs in the diagram at the point where the redriving began.

The following table shows the influence penetration has on the resistance to starting, due to additional surface under friction:

Pile Number.	Period of Rest. Hours.	Number of Blows 1st 6" of Redriving.	Penetration at beginning of Redriving.
5008-3	3	3	18′
5007-2	3	2	24′
5006-1	3¾	4	24′
5005-4	172	6	32′
5001-1	142½	10	33′
5003-3	141	10	34′
5002-2	213¼	13	34′
5004-4	172¾	13	39′

The first 6 ins. of redriving corresponds to the nearly horizontal portion of the heavy line of the diagram and includes the number of blows shown in the table.

Penetration seems to have influenced the resistance to redriving more than the time the piles were allowed to rest.

As above mentioned, the piles were driven in pairs, and all within an area 50 x 80 ft.; the pairs are indicated by the figure following the pile number. In driving, pairs showed the same characteristics while passing through similar strata.

The writer does not attempt to draw conclusions or formulate a theory. The simple facts are given and the results stated, but it is thought that much may be learned by a careful study of the data.

The total amount of material excavated in the Culebra Division of the Isthmian Canal during December was 1,025,485 cu. yds., as against 790,630 cu. yds. in the month of November. Of this amount, 1,020,471 cu. yds. were removed by steam shovels, and 5,014 cu. yds. were loaded by hand at Bas Obispo, for use with the rock crusher. The amount of material removed from the Canal prism was 1,006,026 cu. yds., and from the Camacho and Obispo diversions, 19,459 cu. yds.

Methods and Costs; Some Old; Some New.

Form for Concrete Column.—The accompanying sketch shows a column form used in constructing a factory building by Salmond Bros. Co., Contractors, Arlington, N. J. As will be seen from the sketch no nails are used in framing the form except an occasional 4d to tack the wedges fast after they have been driven. The salvage on the lagging is not reduced by nailing or cutting, while the erection and taking down of the forms involves no carpenter work. Common labor can do all the work of removing, carrying and re-erecting the forms, there being one skilled man only to verify the alignment and plumbing.

Data on Cut Stone Work.—The walls for the building of the Government Printing Office at Washington, D. C., completed in 1903, were built of red bricks trimmed with red sandstone from a quarry near Longmeadow, Mass. The cost of this stone, ready to set, was as follows:

	Per cu. ft.
Plain ashler	$1.80-$2.00
Molded courses	2.00- 2.40
Sills	2.00- 2.40
Lintels	1.95- 2.15
Columns	3.00

In computing these prices, all molded and curved or irregular pieces were squared out to the minimum containing rectangular parallelopipedon. The cost of setting, etc., average for all classes, was as follows:

	Per cu. ft.
Handling	$0.133
Setting	179
Cutting (corrections, etc.)	.018
Pointing	.041
Mortar	.012
Miscellaneous materials	.026
Total	$0.409

The rather high cost is due to the care with which the joints were calked, and to the fact that there was not enough stone to be placed to justify the purchase of a special plant to handle it. Some of the wages paid for 8-hour day on this job were as follows: Laborers, $1.50; stone masons, $4; stone cutters, $4.

Lining Mine Shafts.—A new system has been devised in France for lining mine shafts in water-bearing soil, according to a recent consular report. The new system consists in employing ¾-in iron rings with an interior banking of reinforced concrete in the form of rings of any required depth and acting as supports or arc-boutants to the iron rings with which they are placed in contact, and whose principal object is to protect the concrete from contact with the water. The method of placing this lining is as follows: The thin iron tubbing, constituting the first part of the system, is placed in the ordinary way. At intervals, water faucets are placed to give exit to the water coming from behind the tubbing; this water is conducted to the interior of the mine by temporary pipes, so as not to interfere with the execution of "banking" in concrete, which constitutes the second part of the system. When the concrete has hardened on the surface of the section lining extending between two water-tight passages, the faucets for which a corresponding passage through the cement has been reserved, are closed. The tubbing is then in position supported by the cement lining, and, with the joinings well soldered, prevents the water in any appreciable quantity from coming in contact with the cement. Subsequently through these taps connected with the surface by means of appropriate piping an injection of very thin cement is made under pressure behind the tubbing which thus seals up completely all the issues to the water, insuring in this way indefinite preservation of the work.

Cost of Briquetting Coal.—The following is given by Mr. E. W. Parker as the cost of manufacturing fuel briquettes from anthracite coal dust and coal-tar pitch at a briquetting plant (not named) in operation in New York state:

Pitch:		
6 per cent of pitch, at $10 per ton	$0.60	
Deducting for increased weight of product due to pitch, calculating product at $5 per ton	0.30	
Net cost of pitch		$0.30
Fuel:		
For boiler, broken coal and screenings, broken briquettes, 4 tons per day of 10 hours, at $2.50 per ton = $10; per ton of briquettes		0.10
For heaters, driers, and pitch melting, 3 tons, at $2.50 per ton = $7.50; per ton of briquettes		0.075
Labor:		
1 foreman, per day	$5.00	
2 pitch melters, per day	3.50	
1 dust-bin man, per day	1.75	
1 engineer, per day	3.50	
1 man on second floor, per day	1.75	
1 man on ground floor, per day	1.75	
1 night watchman, per day	1.75	
1 oiler, per day	1.75	
	$20.75	
Per ton of briquettes		$0.21
Miscellaneous:		
Wear and tear per ton of briquettes		$0.10
Lubricating oil per ton of briquettes		0.01
Insurance per ton of briquettes		0.005
Interest on capital invested—$40,000 at 6 per cent		0.10
Office expense, telephone, stenographer, and stationery—$2,000 per annum		0.09
		$0.99
Anthracite dust at $1.40 per long ton, per net ton of briquettes		$1.25
Total cost of briquetting		$2.24
Rebriquetting 3 per cent of breakage and abrasion, charging it back to plant as dust, per ton of briquettes		0.06
Net cost per ton of briquettes		$2.30
Wholesale selling price in bin		$4.80
Net profit per short ton		$2.50

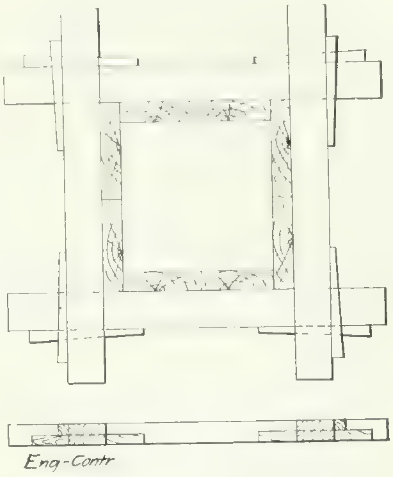
Cost of a Railway Survey.—The following data relate to a survey made in Canada in 1906 for the Grand Trunk Pacific Ry. The lines were run through gently rolling prairie country, with three rather difficult river crossings. The topography was taken 800 ft. on each side of the line, locating 5 ft. contours. The maximum grade was 0.4 per cent, and the maximum curve was 4 degrees. Some rather fast work was done in the survey, for on Oct. 10 12.46 miles of line was located in 8 hours and 20 minutes. An average of 8.4 miles per day was also made in 22 days worked. The organization of the party and wages paid were as follows:

	Per Month.
Locating engineer	$175.00
Transitman	100.00
Levelman	75.00
Topographer	75.00
Draughtsman	75.00
Head flag	45.00
Level rodman	45.00
Head chainman	45.00
Rear chainman	30.00
Topog. chainman	30.00
Topog. rodman	30.00
Rear flagman	30.00
Stakeman	30.00
Axeman	30.00
Cook	60.00
Cookee	30.00
One saddle horse	30.00
Three teams at $100	300.00
Total	$1,235.00

The following is a record of the cost of the survey and the work accomplished:

	Preliminary. 24 Days.	Location. 60 Days.
Miles run and topography taken	175.3	308.0
Total miles location and alternative location	.....	308.0
Total miles preliminary run	175.3	.....
Total number pay roll days	384.0	960.0
Average daily number men	16.0	16.0
Average miles per day	7.3	5.13
Daily cost subsistence per man	$ 0.41	$ 0.41
Average daily pay per man	1.85	1.85
Daily cost for teams	10.67	10.67
Contingencies	18.00	77.00
Daily cost of party	47.83	47.87
Cost per mile	6.55	9.32

The survey was made under the direction of Mr. C. J. Seymour, Kansas City, Mo., to whom we are indebted for the above information.



Sketch Showing Column Form.

In order to demonstrate the utility and economy of its system of temporary steel sheeting for trenches and excavation, the Wemlinger Steel Piling Co., of New York, in open competition secured the contract for constructing a storm sewer at Summit, N. J. The company will build the entire sewer.

An Engineer Appointed as a Member of the New York City Board of Water Supply.

In our Feb. 5 issue we urged the appointment of engineers as members of all boards and commissions having charge of public works. The resignation of a member of the N. Y. City Board of Water Supply formed the text for that week's editorial comment, and now we are glad to be able to announce that an engineer has been appointed as commissioner to fill the vacancy on the Board of Water Supply. Mr. John A. Bensel, M. Am. Soc. C. E., who has served as Dock Commissioner, was appointed by the mayor of New York from a list of three engineers selected by the Chamber of Commerce. The mayor requested the Chamber of Commerce to name engineers only. The wisdom of the mayor's action in asking for an eligible list containing no names other than those of engineers is beyond question the wisest course that could have been pursued.

It may be of interest to our readers to know that each of the three members of the Board of Water Supply receives $12,000 a year, and that their chief engineer receives $16,000. So far as we know, this salary of $16,000 is the largest paid to any chief engineer of any public works project in America. But considering that he is engineer of a project that will involve the expenditure of about $160,000,000, the $16,000 salary is too small. The salaries of the commissioners are reasonable and sufficiently large to be attractive to engineers of ability and wide experience.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0584—**Drop Forgings.** J. H. Williams & Co., New York, N. Y.

The reputation of the above named firm for the variety and extent of its drop forgings is so well established that no special mention need be made of this point. The 114-page book before us catalogs all the various standard forgings and forged articles made by the firm. It lists a complete line of wrenches, crank shafts, connecting rods and other engine parts, besides a large line of smaller articles and tools. Besides the catalog matter proper the pamphlet describes briefly the method of making drop forgings.

No. 0585—**Concrete Steel Bridges.** Concrete Steel Engineering Co., New York.

This company which controls the Melan, Thatcher and other patents for reinforced concrete work was, as many of our readers know, one of the first to extensively construct reinforced concrete bridges in the United States. Altogether it has built many scores of such bridges and in this 96-page pamphlet a large number of these bridges are illustrated. Each bridge is very briefly described. The great variety of designs and types of structures shown in these views should be of interest to engineers or municipalities having bridge work to do.

No. 0586 **Wheel Scrapers.** Western Wheel Scraper Co., Aurora, Ill.

Besides wheel scrapers this 104-page pamphlet illustrates and describes drag scrapers, plows, dump-cars, elevating graders, dump wagons and carts, road machines and stone crushers. A brief history is given of the Western wheel scraper and this is followed by a general description of the machine and illustrations of the several sizes and types. Each of the other machines and tools named above is described in an equally complete way. A special description is given of the air dumping device for dump cars and of the Western standard spreader car. The catalog is an excellent one in all its particulars and should be secured by contractors and engineers interested in this class of machinery.

No. 0587—**Filters.** Federal Filtration System, New York City.

This 28-page pamphlet illustrates and describes briefly the several types of filters made by the company named. These filters are especially designed for filtering for private houses and buildings. Sizes and dimensions are given together with a list of firms who have used the filters.

No. 0588—**Steam Turbines.** De Laval Turbine Co., New York City.

This 28-page pamphlet describes the De Laval steam turbine engine. Separate engines are shown and also combinations of engines with dynamos, blowers and centrifugal pumps. The descriptive matter is good and the pamphlet is well gotten up.

No. 0589—**Gasoline Engines.** Hart-Parr Co., Charles City, Iowa.

This 40-page pamphlet describes the various types of traction, portable and stationary gasoline and kerosene engines made by the firm named. The characteristic construction of the Hart-Parr engine is described in detail. A separate pamphlet describes the application of traction engines to plowing. The descriptive portion of the pamphlet is exceedingly well written and illustrated. Altogether this is one of the most satisfactory descriptive catalogs which we have seen for some time.

No. 0590—**Terra Cotta Fireproofing.** Henry Maurer & Son, New York City.

This is an illustrated descriptive catalog of the Herculean flat arch and the Phoenix hollow wall construction. Drawings are given showing typical construction and giving weights, dimensions, etc., of material. In addition there are a number of half-tone views of terra cotta fireproofed buildings and a list of testimonial letters from architects, engineers and others who have used these constructions.

No. 0591—**Spiral Riveted Pipe.** American Spiral Pipe Works, Chicago, Ill.

The purpose of this pamphlet is to call attention to the many different uses for which spiral riveted pipe is especially adapted. This style of pipe is briefly described and illustrations are given of a number of pipe lines for various purposes in which it has been used. A section of the pamphlet is devoted especially to illustrations of joints for spiral riveted pipe.

No. 0592—**Chimneys.** Alphons Custodis Chimney Construction Co., New York.

As is known to most of the readers, this company builds chimneys of a special perforated radial brick. This pamphlet, which contains 113 pages, describes the construction of this brick and shows its application in chimney construction. There is a brief discussion of chimney design and numerous illustrations are given of chimneys for manufacturing plants and other purposes. The pamphlet concludes with a set of tables showing sizes of chimneys for steam boilers.

No. 0593—**Flush Tanks.** Pacific Flush Tank Co., Chicago, Ill.

This company controls a large number of designs for automatic intermittent flush tank syphons without moving parts. The construction and operation of these syphons are described and illustrations are given showing the syphons in place and in operation. Specifications for flush tanks are presented. The pamphlet gives an excellent description of a well-known device and should be had by city engineers.

No. 0594—**Drilling Machinery.**—The Christman Co., Massillon, O.

This 80-page pamphlet describes and illustrates miner's drills and drilling machinery for all purposes. Among the machines listed are machines for oil, gas and water well drilling, borings for foundations, tunnels, etc., test holes for coal mines, blast hole, drills for contractors, and mining drills. The catalog is very complete and useful and gives much information as to drilling methods and machinery.

Personals.

Mr. Charles M. Slocum has been re-elected City Engineer of Springfield, Mass.

J. W. Field, Chief Engineer of the Wichita Falls & Northwestern Ry., died Feb. 5, at Wichita Falls, Tex.

Mr. Leland W. Irish has resigned his position as Assistant Engineer to the Board of Water Supply of New York City.

Robert W. Hamilton, one of the oldest hydraulic engineers in the country, died Feb. 11, at his home in Pittsfield, Mass., aged 82 years.

Mr. D. B. Zehner has been appointed Division Engineer of the Wyoming Division of the Lehigh Valley R. R., suceeeding Mr. John A. Zehner, transferred.

Mr. Alexander Bonnyman, heretofore Chief Engineer of the Atlanta, Birmingham & Atlantic R. R., has been appointed General Manager with headquarters at Atlanta, Ga.

Mr. Patrick O'Donnell has been appointed superintendent of construction work on the Buffalo Division of the New York, Chicago & St. Louis Ry., with headquarters at Buffalo, N. Y.

Henry C. Colburn, President of the Detroit Bridge & Iron Works, Detroit, Mich., until the absorption of that company by the American Bridge Co., died Feb. 6, at his home in that city.

Mr. W. M. Hobbs has been appointed General Superintendent of the Southern Pacific lines in Louisiana, succeeding Mr. E. B. Cushing, who becomes Consulting Engineer at Houston, Tex.

Mr. R. P. Black, heretofore Division Engineer of the Toledo & Ohio Central Ry., at Bucyrus, O., has been appointed Division Engineer of the Kanawha & Michigan Ry., with headquarters at Charleston, W. Va.

The firm of Crane & Sturgis, Civil and Consulting Engineers of New York City, has dissolved partnership by mutual consent. The business will be continued by Mr. C. A. Crane, with offices at 505 Tremont Ave., New York City.

Mr. Albert T. Perkins, Consulting Engineer to the Municipal Bridge and Terminals Commission of St. Louis, Mo., has been appointed Assistant President and Assistant Syndicate Manager of the St. Louis, Brownsville & Mexico R. R., in Texas.

Mr. E. L. Shaw, formerly City Engineer of Marinette, Wis., has opened an office in the Monadnock Block, Chicago, Ill., where he will engage in a consulting practice, making a specialty of bridges, buildings, foundations and municipal work.

Mr. J. L. Mann, Engineer U. S. Reclamation Service, has been granted a furlough and has taken charge of irrigation work for the Dominican Government. At present Mr. Mann is making studies relative to irrigation in the Province of Monte Cristi.

Mr. Robert McF. Doble, Consulting and Supervising Engineer, making a specialty of Hydro-Electric Power Development and Transmission, formerly of San Francisco, Cal., has removed his office from Colorado Springs to 528 Majestic Building, Denver, Colo.

Mr. E. F. Layman formerly Sewerage Engineer of the city of Cincinnati, O., has opened an office in the Blymer Building, Room 64, 514 Main St., Cincinnati, O., where he will engage in general practice as civil engineer, special attention being paid to sewerage, water supply, municipal improvements, examinations, estimates and reports.

The G. Drouve Co., of Bridgeport, Conn., manufacturers of skylights, ventilators, etc., at the annual meeting of their directors, held Feb. 3, 1908, elected Mr. G. Drouve as President and Treasurer and Mr. William V. Dee as Secretary of the Company. Mr. Dee, who recently resigned from The Railway Age to take an interest in the company, has been appointed General Sales Manager.

Mr. T. S. Reilly, until recently Associate Editor of the Railway and Engineering Review, has been appointed to the position of Mechanical Superintendent of the Canton & Hankow R. R., at Canton, China. Mr. Reilly was graduated from the Civil Engineering Department of the Pennsylvania Military College in 1890 and since that time he has been employed in the mechanical department of railroads, for a time as general foreman of the San Antonio & Aransas Pass Ry. at San Antonio, Tex.; also as master mechanic of the St. Louis & San Francisco in the Oklahoma and Indian Territory districts. He went to Cuba as mechanical expert for the Galena Signal Oil Co., and in 1905 became connected with the editorial department of the Review.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13 21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T MURRAY, F. A. SMITH, . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance).— ***$2.00*** *a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*

$2.50 *a year (52 issues) to Dominion of Canada.*

$3 00 *a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Entered as second-class matter April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

Some Misstatements as to Concrete Mixers 119
An Investigation of Impermeable Concrete 119

CONCRETE SECTION:

Investigations of Impermeable Concrete by the Laboratory of the Board of Water Supply, New York City 120
A Simple Statement of the Behavior of Concrete in Compression and a Discussion of Column Design. 121
Suggestions on Form Construction for Reinforced Concrete Building Work. 123
Steel Centers and Lagging for Constructing Concrete Lining for Tunnels 124

EARTH AND ROCK SECTION:

Cost Data on Earth Excavation and on Rubble Masonry and Methods of Recording Same. 125
The Cost of Grading a Wagon Road in Winter. 126
The Original Estimate of the Ashokan Reservoir Made by the Burr-Hering-Freeman Commission. . . . 127

GENERAL ARTICLES:

METHODS AND COSTS:

Road Treatment with Oil—Replacing Broken Cross Wires in Field Instruments—Steam Scraper work. . . . 128

LETTERS TO THE EDITORS:

Some Additional Data on the Method and Cost of Constructing Reinforced Concrete Poles—Methods and Cost of Excavating Sewer Trench with Steam Shovels. 129
CATALOGS WORTH HAVING. 130
PERSONALS 130

Investigations of Impermeable Concrete.

Elsewhere in this issue we give an outline of the series of investigations made at the laboratory of the Board of Water Supply of New York city to determine some of the possibilities in the way of rendering concrete impervious to water. So much has been written concerning these investigations and of their wonderful promise that we request our readers to read Mr. Davis' very sane and conservative summary of the work which has been done. Briefly stated, the studies that have been made show that the addition of some 5 to 10 per cent of colloidal clay to mortar makes it impervious, that the addition of about 3½ per cent of potash alum does the same, that fine sand mortars rich in cement are more impervious than others and that permeability usually decreases with time due to what is commonly defined as the "silting up" of the concrete

In respect to the action of colloidal clay the work done by the laboratory presents features of decided novelty. This is particularly true of the scientific explanation of the action of this material which has been worked out. The waterproofing value of alum admixtures is not a new discovery and neither are the other phenomena cited above. If, however, by adding a small percentage of clay in colloidal form to cement we can produce a water tight concrete we have a means of waterproofing which, as Mr. Davis says, "may prove of special value." The reservation in this statement should be noted. As Mr. Davis states we do not know the effect of the admixture on permanency of strength and on soundness. Assuming that this effect is unimportant we then come to the practicable possibilities of claying cement.

It is one thing to clay a laboratory sample and it is a different thing to clay a thousand or ten thousand barrels in practical construction work. It is a task which will have to be performed at the cement mill and it is a task which if it does not add to the cost will certainly add to the limitations which the manufacturers will for some time at least put in their guarantees of strength, soundness, etc. Indeed the practical problems of the task grow as we consider them.

In making these statements we do not minimize the value of the work that has been done under Mr. Davis' direction. His own reserve in commending the practical value of this work is in our opinion its strongest recommendation, and we expect to see much practical good resulting from the work of the laboratory which is in his charge. In conclusion it must not be forgotten that the task of waterproofing a concrete structure does not end with the discovery of an impermeable concrete.

The Guatemala Northern Ry., the third railway across Central America, was opened on Jan 10, 1908

Some Misstatements as to Concrete Mixers.

In our last issue we reprinted a paper by L. C. Wason, in which Mr. Wason said: "Mixers are of two general types, the continuous and the batch. The continuous can be divided into those with and those without power. Without power the principal machines are the Portable Gravity and the Hains mixer, which is a series of conical hoppers supported one above another. The principle of both of these is identical; a concave inclined surface with pins inclined relatively to the surface of the machine."

We wish to correct the error in the last sentence, for the principles of these two types of gravity mixers are not identical—further than that, they both depend upon gravity to move the materials. But if any mixer in which gravity plays a part is to be thrown into one general classification, then practically all mixers are gravity mixers. The various rotating batch mixers elevate the materials, which then fall under the influence of gravity.

The Hains mixer has three conical hoppers, one above the other, but it has no pins inclined relatively to the surface of the machine." Whereas, the Portable Gravity mixer has "pins," but does not have conical hoppers. These differences in design affect the principle of operation of these two types of gravity mixers in a marked degree. The Hains mixer thus becomes a *batch* mixer, for a complete batch is first charged into the upper hopper before the gate of the hopper is opened. Then, upon opening the gate, the batch discharges itself, hourglass fashion, into the next lower hopper, whose gate is kept closed. Then that gate is opened and the batch passes to the next hopper, and so on. It is clear, therefore, that the Hains mixer is not identical in principle with the Portable Gravity, and that it is not even a "continuous mixer," but is a batch mixer

Mr. Wason says further, speaking of continuous mixers with automatic feed: "These machines are not much used now, due chiefly to this uncertainty [of feeding the materials in right proportions] and in part because they are not as economical to operate as a good batch mixer."

Now the fact is that continuous mixers *are* "much used," particularly on street work, and there are certain makes of these mixers in which the automatic feed is wholly reliable.

Mr. Wason should at least have studied the catalogs of the two types of gravity mixers somewhat before labeling them as identical in principle, and he should have studied the operation of "automatic feeds" before declaring them a failure.

The government of Manitoba, Canada, has taken over all the telephone lines heretofore operated by private companies in that province. The purchase price was $3,400,000.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Investigations of Impermeable Concrete by the Laboratory of the Board of Water Supply, New York City.*

BY JAMES L. DAVIS.

This paper does not deal with all the prominent phases of the general problem of waterproofing concrete. Attention is given instead to some of the tests made in the laboratory of which the writer has charge, that of the Board of Water Supply of the City of New York. The data here given should be considered as but the beginning instead of the final results of a series of investigations. In consideration of the short time during which our tests have been under the way, the best that can be done is to point out certain possible tendencies in different classes of materials and methods. The major part of our investigations to the present time have been aimed toward securing impermeability of mass.

The writer believes permeability tests of mortar and concrete are the most difficult tests to make successfully that are applied to these materials. Even with the greatest care in every operation of making, storing and testing, widely discordant results will usually be found between the several specimens of a series intended to represent identical conditions. The writer considers three specimens the fewest possible number which should constitute any test. For new materials, the general behavior of which are unknown, he employs six specimens in every test.

The chemical, physical and electrolytic changes which occur within a mass of wet cement and aggregate are so complex and so little understood that science can but vaguely indicate the causes which produce these clashing results, or point the way to their remedy. Little is known of the extent to which these discrepancies may be due to variations in physical and chemical composition of the cement, the degree of compacting the specimens, or to other recognized accidents of making, or to variations in moisture or temperature during subsequent storage, or even to method of storage, as whether in air, water or sand. The present stage is that of experiment and compilation of facts, at best an art in a crude state.

Experiments at this laboratory are usually made on two forms of specimens, 2-in. cubes for cement and mortar, and cylinders 8 ins. in diameter and 6 ins. in length for concrete. The water is applied under pressure over the full end area of the specimen, and is forced through its entire length. Our usual method is to determine by means of the more easily made and tested 2-in. mortar cubes whether any material proposed for concrete possesses any degree of waterproofing merit, as a preliminary to the concrete tests.

The effects on the strength of concrete of any waterproofing material incorporated in the mass is of parallel interest with its effect on permeability. Corresponding strength tests in both tension and compression for mortar and in comparison for concrete are usually made.

In comparing differing aggregates by means of permeability tests, consideration is given to the variations in volume due to differing specific gravities, such weights of each being taken as will give equal absolute volumes, that is, equal volumes of solid particles. Our standard of specific gravity for aggregate is 2.67, that of Cow Bay material.

For materials used as a substitute for Portland cement, a similar correction applies, the specific gravity of Portland cement being taken at 3.15. For example, if a natural cement of specific gravity 2.90 is to be compared with Portland cement, the weight of the natural cement taken is corrected in the ratio of 2.90 ÷ 3.15, this method giving equal volumes of absolutely solid particles of the two materials. Equal weights of the two materials would obviously result in richer volumetric proportions of natural cement mortar.

Attention is here called to the necessity of ascertaining for the interpretation of published results of tests in which natural cements, hydrated lime or other light specific gravity materials have been substituted for Portland cement, whether the proportions were taken by weight or by absolute volumes.

Our standard permeability test is to place the specimen at twenty-eight days' age under forty pounds hydrostatic pressure for a period of one hour, the leakage reported being the total amount in grams passing during the last ten minutes of the test. For certain purposes, the results are expressed as gallons per square foot per hour.

Clay and Alum.—A paper on waterproofing of concrete recently contributed to the Transactions of the American Society of Civil Engineers by Mr. Richard H. Gaines, chemist of the Board of Water Supply, has attracted wide attention and received much favorable comment. So widely has Mr. Gaines' paper been quoted that it is unnecessary for me to repeat the results of his researches here. Only the briefest summary will be given.

Mr. Gaines showed by experiment that practically impervious mortar of 1:3 proportions with ungraded Cow Bay sand can be secured either by the substitution of 5 to 10 per cent of finely powdered colloidal clay for an equal weight of sand, or by replacing the mixing water with a 2½ or a 5 per cent solution of potash alum, or by a combination of both processes. The reasons for the adoption of these processes and the explanation of their action involves the discussion of several phases of molecular physics and electro-chemistry, which are too complex to introduce here. Experiments with these materials have been continued and extended to tests on concrete specimens 8 x 6 ins. in size. The results so far generally confirm the earlier experiments in giving both decreased permeability and increased strength. For lack of sufficient experimental data and the final trial of application to practical conditions, claim is not made that the solution of the waterproofing problem has been found. Results so far warrant considering these processes as probably of great value.

Strength tests to three months' age with commercial hydrated lime indicate that the tensile strength is slightly reduced by 5 per cent and reduced 20 per cent by 10 per cent hydrated lime; for greater percentages of lime there is increased loss of strength. In compression, there was generally a small gain in strength to three months with 5 and 10 per cent hydrated lime, but a loss at the six months' period. One brand of lime showed a gain in strength to three months' age where proportions up to 30 per cent were used, but a final loss at six months.

It is recognized that these tests are not sufficiently extensive to prove the merits of this class of materials as waterproofing. Regarding their chemical action, Mr. Gaines states: "Hydrated lime is but very slightly soluble, and there can be little chemical action resulting from its use unless in the presence of an electrolyte." Its action in decreasing permeability under ordinary conditions of use must therefore be physical rather than chemical, and must consist in amply filling the pores by its finely subdivided particles.

Portland Cement and Fine Sand Mortar.—The use of fine sands with crusher-run stone or ordinary gravel as coarse aggregate with usual proportions of cement, the writer considers a method of some promise. Four fine sands of similar mineralogical composition, chiefly rounded quartz grains, were found to be absolutely impervious under 40 pounds pressure in 1:3 proportions at 28 days' age.

Tests show that a fair degree of impermeability can be secured by the use of a sufficiently fine sand without special care in the grading of the coarse aggregate. It should be observed that these are not rich mixes, the percentage of cement being 12.5 by weight, corresponding to proportions about 1:8 by volume.

---

*A paper read at the annual convention of the National Cement Users' Association at Buffalo, N. Y., Feb. 19-21, 1908.

These last tests are an exception to the general rule that permeability decreases with age of specimen, as the tests at 35 days' age show. Also the leakage increases in greater ratio than the pressure, which is contrary to usual experience. These results were obtained but recently and the causes of these peculiarities are unknown.

Numerous tests have shown marked decrease in permeability with age. In a recent one in which the specimen was immersed in water six days between the tests, the permeability was decreased from 1,740 to 705 grams. In a test of mortars, the decrease was from 72 to 34 grams. The time between tests was three days, and the storage in damp sand.

The writer believes the greatest advancement in waterproofing for general purposes, such as the construction of basement floors, walls, conduits and dams, is to come through securing practically impervious mass concrete, rather than by the use of surface washes or asphaltic coatings, useful as these may be in many cases For resistance up to, say 50 ft. head of water, the art is sufficiently advanced so that the question is which of several processes is the cheapest, rather than is it practicable to build water-tight work in concrete.

Generous use of Portland cement will secure impervious concrete. Several structures, such as reinforced dams, stand-pipes and tanks, have been successfully built with the concrete mixed in the ordinary manner in proportions about 1:2:4 or 1:2:3, without special care other than to secure a wet consistency. These results are in general confirmed by the investigations of this laboratory. Tests show that ordinary sands in mortar in proportion 1:2½ or richer are impervious. Also, so-called sand or silica cements make a somewhat tighter mortar than Portland cements.

By scientifically grading the aggregate, Wm. B. Fuller has successfully built tanks with thin walls, of proportions about 1:3:7. Whether it is cheaper to use the larger quantity of cement or to grade the aggregate depends upon the relative local prices of cement and of aggregate, and the size of the work. These are the proved methods that are free from doubt as to enduring efficiency and strength, and are of reasonable costs.

It should be remembered that troweling on a plaster coat of mortar and washing with thin grout are but modifications of use of rich proportions of Portland cement.

The use of finer sand than is usually accepted for ordinary concrete work may prove to be of special value. Its advantage, if successful, will consist simply in cheapening the process of grading ordinary materials to an ideal analysis. Its effect on reducing strength is well known, and its use will in some cases be limited by strength requirements.

Puzzolan and sand cements are superior to Portlands in securing impermeability, but they are somewhat inferior in the sand. Colloidal clay as a substitute for 5 and 10 per cent of the sand, or the substitution of 1 or 2½ per cent solutions of alum sulphate, or possibly other electrolytes for the mixing water, may prove cheap and effective processes. The writer holds aloof from stronger recommendations at this time because of the limited range of experiments, and the undetermined effect on permanence of strength. Successful application of the clay process would require special appliances for drying, pulverizing and mixing.

The degree of imperviousness which may be expected from methods above described is such as to meet ordinary conditions. as the demand for dry basements, roofs and walls, and the storage of water or its conveyance under moderate heads without objectionable loss or resulting damage from its escape.

One of the results of investigations at this laboratory has been to confirm the often observed phenomenon of increasing imperviousness with time, commonly called the result of the "silting up" of the concrete. The action has not been fully explained, but whether it is physical or chemical, or whether it has some analogy to the "schmutzdecke" of the sand filter, he who would construct impervious concrete may count upon its coming to his aid, at least under conditions of moderate head of water in continued contact.

One set of experiments with mixtures as lean as 1:4:14 intended to secure the maximum possible degree of permeability to serve as drainage blocks through which seepage water might be carried away, became so nearly impervious in 24 hours under a head of 20 ins. as to make their use for the purpose intended doubtful. This was with the flow perpendicular to the bed of the blocks. With the blocks so placed that the flow was parallel to the bed, the flow was greatly increased.

The total number of poles, more than 20 ft. long, purchased during 1906 by telegraph, telephone, electric companies, etc., according to a recent circular of the U. S. Forest Service, was 3,574,666, valued at $9,471,171 at the point of purchase. The average value per pole at point of purchase of the principal kind of round poles was as follows:

Length	—25 ft	30 ft.	35 ft	40 ft.	45 ft.
Cedar	$1.19	$3.22	$4.94	$6.17	$9.08
Chestnut	1.42	2.52	3.35	4.64	7.08
Cypress	1.09	1.24	3.04	4.42	6.28
Juniper	1.62	2.70	3.68	4.09	5.76
Pine	1.68	3.18	4.84	5.13	12.41
Oak	1.16	2.11	...	...	2.44
Fir	1.49	2.31	2.72	2.85	4.00

A Simple Statement of the Behavior of Concrete in Compression and a Discussion of Column Design.*

CONCRETE IN COMPRESSION.

Concrete is a hard and brittle material, and, like all such brittle materials, it has a much greater strength in compression than in tension. Concrete is often ten times as strong in compression as in tension, and the average value of the ratio of the strengths may be about eight. If a short block of concrete, having a length of two or three times its lateral dimensions, be subjected to a compressive test, it may be observed to shorten in the direction of the applied force (supposed to be applied on the ends), and to increase in its lateral dimensions. If the concrete were perfectly elastic, the changes in its dimensions would be exactly in proportion to the intensity of the applied loads, and the ratio of the load per square inch to the shortening per inch of length would be the modulus of elasticity for the material. Concrete is found to have no such constant relation of stress to deformation, but, as the loading is increased, the shortening increases at a faster rate than the loading. If the deformations and loads be plotted as coordinates, a curved line will generally result. Examination of data of many tests will show that a parabola, having its axis parallel to the axis for loads and its vertex at the ultimate or breaking strength of the concrete, may well represent the average compression diagram. If the rate of deformation be considered constant between certain points on the curve, then the increase in unit loading between these points, divided by the accompanying deformation may be considered as the modulus of elasticity within those limits. For loads from zero to one-fourth or one-fifth of the ultimate strength, a straight line will differ very little from the curve, and the modulus may be considered as the initial modulus of elasticity of the materials. If a straight line be drawn from 0 to the end of the curve, its inclination is one-half that of the tangent at 0, or, if it be considered as giving the ratio of stress to deformation the modulus between these limits is approximately one-half of the initial modulus.

Measurements of the increase in lateral dimensions due to the loading also show similarly growing deformations as the loads are increased. The ratio of lateral deformation to longitudinal deformation (Poisson's ratio) is not well determined, but all recorded experiments seem to show that it is not greater than 1/5 and possibly as small as 1/8 or 1/10.

With plain concrete in compression there is little need for knowledge of the elastic properties of the material, but if metal reinforcement is used, such knowledge is of primary importance. In Fig. 2, let steel bars be placed within the concrete when it is molded, and let the ends of the bars exactly face with the concrete on the testing heads. It is clear that the two materials will, under loads, shorten the same amount, and that the stress in each may be known if the modulus of elasticity of each be known.

---

*Extracted from an article in the "Journal Worcester Polytechnic Institute," January, 1908.

Let E_s = the modulus of elasticity of the steel.
E_c = the modulus of elasticity for the concrete, from 0 stress to the applied stress.
e = the shortening of the specimen per inch of length.
C_s = the compressive stress in the steel.
C_c = the compressive stress in the concrete.

Then $e = \frac{C_s}{E_s} = \frac{C_c}{E_c}$ or $\frac{C_s}{C_c} = \frac{E_s}{E_c}$ or $C_s = \frac{E_s}{E_c} C_c$

Let the ratio of $\frac{E_s}{E_c} = n$ then $C_s = n\, C_c$

Example.—Suppose that it is desired to limit the working stress on the concrete to 500 lbs. per sq. in., and that at this stress the $E_c = 2{,}000{,}000$. Taking the $E_s = 30{,}000{,}000$ the steel would be stressed to

$$500 \times \frac{30{,}000{,}000}{2{,}000{,}000} = 7{,}500 \text{ lbs. per sq. in.}$$

Or a convenient way to consider the steel is to count each square inch of its area as equivalent to 15 sq. ins. of concrete.

If the concrete block be 10 × 10 ins., and the bars four in number with 1 sq. in. in each, the equivalent concrete area would be $10 \times 10 + (4 \times 15) - 4 = 154$ sq. ins. and the total load which could be taken by the block

$$P = 154 \times 500 = 77{,}000 \text{ lbs.}$$

Should the loading be increased up to the point of failure, the E_c would decrease to approximately 1,000,000, and n would then be 30, and the stress in the steel corresponding to the ultimate strength of the concrete would be $C_s = 30\, C_c$. Let the ultimate strength of the concrete be 2,000 lbs. Then the stress in the steel would be $2{,}000 \times 30 = 15{,}000$ lbs. per sq. in. and the block in the example might be expected to fail at

$$P' = (10 \times 10 + 30 \times 4 - 4)\ 2{,}000 = 432{,}000 \text{ lbs.}$$

Columns which do not exceed 12 to 15 diameters in length have been found to fail in practically the same manner as blocks of two or three diameters in length, that is, deflection is negligible. Two methods for determining the design of columns may be used. In the first, a *safe working stress* is set for the concrete and the stress in the steel determined by the ratios of the elasticities of steel and concrete. In the second method, the *ultimate strength* of the column is computed, and a factor of safety used by which to divide the breaking load to obtain the safe loading.

In the examples above given, the first method gives a safe loading of 77,000 lbs. If a factor of four is desired, the second method would give a safe loading of ¼ × 432,000 = 108,000 lbs., or with 5 as a factor, 86,400 lbs. The first method is used much more generally than the second, and is the method specified by the building ordinances of most cities which have formulated laws for concrete construction.

In theory, the use of steel to increase the carrying capacity of a compression member is not economical, for the steel costs roughly 25 times as much per volume as concrete, while it is worth only from 10 to 15 times the same volume of concrete, based upon the stresses it can receive under safe working conditions. There are other reasons, however, for its use in columns. Eccentric loads may bring tension upon one side of the column, or there may be bending stresses due to wind loads or to other lateral stresses. The steel also takes less room for the same carrying capacity, and in many cases this consideration alone may well cause the introduction of large amounts of this material. Columns in the lower stories of high buildings become extremely large when depending principally on the strength of concrete, and for such locations the practice is growing of making the steel the principal load-carrying member and of considering the concrete as little more than protection from fire and rust. In such cases the working stresses adopted for the steel are taken with little regard to the strength of the concrete, it being given no consideration as a load carrier. Such treatment may result in spalling of the concrete due to the large deformation of the steel, but it may be easily patched, and, if applied to the steel after much of the dead load stress is already in the steel, little trouble will result.

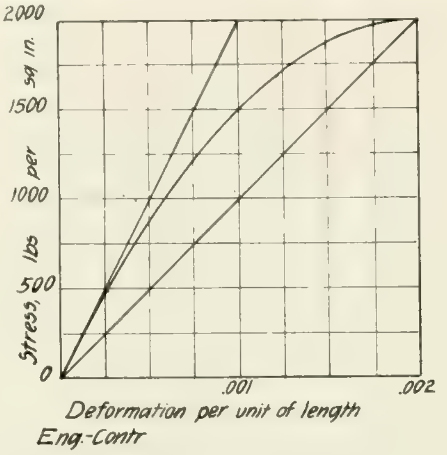


Fig. 1—Compression Diagram for Concrete.

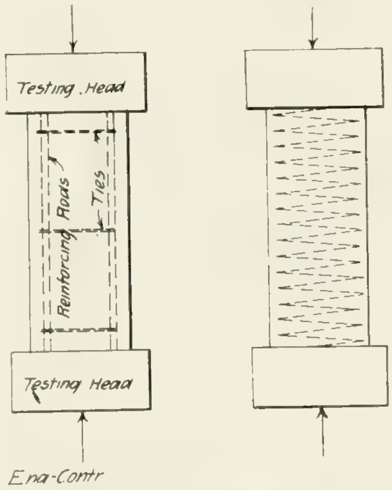


Fig. 2—Diagram Showing Types of Column Reinforcement.

An influence which modifies the division of the load between the steel and concrete is the shrinkage which takes place in concrete which sets and ages in air. This shrinkage puts the steel into initial compression and the concrete into tension. From this cause the steel will take more of the compression than shown in the usual analysis.

Columns with longitudinal reinforcing should have the steel near the outside of the column; a cover of 2 ins. is usually demanded for fire protection, and the separate bars or rods should be tied together by small bars or wires, and such ties should not be spaced more than the diameter of the column apart. The ties serve to hold the steel in line and also take up the shearing stresses which may be present. Longitudinal rods should have provision for applying the load to them. This may be done by extending them into enlarged footings at the base and into enlarged sections at the junction of the column with beams and girders at the top to such a length that the bond stresses between steel and concrete do not exceed safe limits. Or the bars may face upon steel plates and thus distribute the stresses which they carry.

HOOPED COLUMNS.

If a concrete column be wound with steel spirals, or hooped with rings of steel, its lateral deformation may be partially restrained. If such a spiral be embedded in the concrete when molded, it will be without tensile stress, for the concrete core tends to draw away from it, due to its shrinkage in the setting process. As loads are applied to the column ends the lateral dimensions increase and the steel bands or spirals are given tension.

Considering that the working stress in the longitudinal steel rods was seen to be only 7,500 lbs. in the example cited, and that the lateral increase in dimensions is only say 1/5 as great as the longitudinal change, it is evident that under low working stresses in the concrete there will be but trifling stresses in the hoops. If the loading increase and approach the ultimate strength of the concrete, the deformations increase and the hoops may play a very important part in preventing collapse. Such is a brief outline of what must be expected of hooped columns, based upon our common knowledge of the elastic behavior of concrete. Such is also the result of observation of tests made upon hooped columns.

They always allow high ultimate loads but suffer great deformation before failure. The extreme case would be when the hoops are so close together as to form a closed cylinder and the concrete had become only a mass of broken fragments.

If the method of design based upon assigning safe loads to the concrete be used, there is no logical way in which hoops can be computed to be of much service. They are, however, a safeguard against sudden collapse, and may allow the column to be greatly overloaded, even to the point where the concrete spalls off the sides of the column.

If the method of ultimate loads with a factor of safety be used, the conclusions of M. Considère may be used. He recommends that the hoops should have a diameter of about 1/40 of the diameter of the concrete within the spiral, that they should be spaced from ⅛ to 1/6 the diameter of the column apart, and that the volume of the steel so used be considered as 2.4 times as effective as an equal volume of steel used as vertical reinforcing. The concrete without the spiral should not be counted in the section taking compression. Vertical or longitudinal reinforcing should always be used with the hooping if the column is subjected to flexure from any cause, for spirals offer no resistance to this kind of stress.

Example.—What load could be placed upon a concrete column having a length of 10 ft. and a diameter of 12 ins., which is reinforced by a spiral on a diameter of 10 ins., made of ¼-in. wire with a pitch of 1¼ ins., if a factor of four is desired?

Circumference of spiral, 31.4 in.

Number of spirals, $\dfrac{120}{1\frac{1}{2}} = 80$

Length of wire, $\dfrac{31.4 \times 80}{12} = 210$ ft.

Equivalent longitudinal reinforcing 21—¼-in. rods or $.049 \times 21 = 1.03$ sq. in.

Value of spirals $1.03 \times 2.4 = 2.47$ sq. in.

Area of concrete 10 ins. dia. $= 78.54$ sq. in.

Taking strength of concrete at 2,000 and the value of n as 30

$$\begin{array}{rl} & (78.54 \times 2{,}000) = 157{,}080 \\ P' = & (2.47 \times 30 \times 2{,}000) = 148{,}200 \\ & \hline \\ & \qquad\qquad\qquad\qquad 305{,}280 \end{array}$$

$$P = \tfrac{1}{4} P' = 76{,}320 \text{ lbs.}$$

The same column with 1.03 sq. ins. of longitudinal reinforcing would have a computed strength of

$$P' = (78.54 - 1.03)\ 2{,}000 + 1.03 \times 2{,}000 \times 30 = 216{,}800 \text{ and } P = \tfrac{1}{4} P' = 54{,}200 \text{ lbs.}$$

The above examples are not given as directions for design of columns, but to illustrate the application of principles. Such great variation is possible in concrete, and there are so many varying conditions which each particular design must satisfy that each designer must be his own judge of the factors to use.

ALLOWABLE STRESSES IN COLUMNS BY VARIOUS GOVERNMENT AND MUNICIPAL REGULATIONS.

Regulations issued by the Prussian Minister of Public Works, in 1904, direct that the concrete in columns under 18 diameters in length shall not be stressed above 1/10 of its breaking, as determined by test upon 12-in. cubes. Steel reinforcing is to be allowed a stress of fifteen times that of concrete.

The French Ministry of Public Works gives the following rule in regard to columns:

The compressive stress in reinforced concrete shall not exceed 0.28 of the crushing strength of plain concrete of the same composition at the age of 90 days (tested in 8-in. cubes). Higher stresses are permissible only when the concrete is hooped, or has transverse reinforcing adapted to resist the swelling of the concrete under the influence of longitudinal compression, but in any case the maximum stress shall never exceed 0.60 the crushing strength. Steel used as longitudinal reinforcing is allowed a stress of from 8 to 15 times that of the concrete, the smaller factor being used when the cross ties are at intervals equal to the least dimension of the column, and the larger, when the cross ties are as close as one-third the least dimension of the column. Hooped columns are allowed a stress per square inch, by the formula $p = 0.28\left(1 + n\dfrac{V'}{V}\right)$ (ultimate strength), where V′ is the volume of the hooping and V the volume of the concrete for the given length of column, and where n is to be taken as 15 when the spacing of the hoops or spirals is as great as two-fifths the least dimension of the column, and 32 when the spacing is as close as one-fifth the same dimension. Allowance for varying stresses and impact is to be made by reducing these stresses. These allowable stresses have been severely criticised by many authorities as too high, and could be accepted only when the mixing and placing of the concrete receives the greatest care and inspection.

A joint committee from the Royal Institute of British Architects, the District Surveyors' Association, the Institute of Builders, the Municipal and County Engineers, the War Office, the Admiralty, and private engineers, has formulated a code for British practice in which columns are treated as follows: With concrete capable of testing, in cubes, from 2,400 to 3,000 lbs. per sq. in., in 28 days (a 1:2:4 mixture should do this), 500 lbs. per sq. in. is allowable in columns not longer than eighteen times the least dimension. 7,500 lbs. per. sq. in. is taken as the stress in the reinforcing steel. Gordon's formula for reducing the allowable loading on columns having greater lengths is used. For convenience this may be stated as follows: for columns longer than 18 diameters, multiply the load to be carried by the factors given below and design the column for the new loads as though the length were only 18 diameters. For L ÷ d = 20, use 1.13 W; for L ÷ d = 25, 1.20 W; for L ÷ d = 30, 1.29 W.

The New York City Building Code of 1903 allows the use of reinforced concrete columns, not longer than 12 diameters, with unit stress of 350 lbs. and a ratio of 12 between the stress in the steel to the stress in the concrete. As the law specifies a 1:2:4 concrete it would seem to be very conservative.

The Philadelphia Building Regulations (adopted in 1907) allow a unit stress of 500 lbs. on concrete made of cement, sand and broken stone in the proportions of 1:2:4, and fix the stress allowable in the longitudinal reinforcing at twelve times that in the concrete. 1,000 lbs. is allowed on the concrete within the hooping of hooped columns, provided the percentage of longitudinal rods and the spacing of the hoops be such as to permit the concrete to develop safely such stress with a factor of safety of four. This is indefinite enough to suit any notion as to the behavior of hooping.

Suggestions on Form Construction for Reinforced Concrete Building Work.*

The construction of the forms is probably the greatest problem in the practical construction of reinforced concrete. Almost every beginner in this field has arrogant confidence in his ability to eclipse everything previously done in the way of perfect centering. It is only necessary to watch such an one and see a second scheme in his second job, a third scheme in his third job, and so on, until he becomes a meek plodder along the tow-path of experience.

A discrimination should be made between centers or forms designed for a building, and a building designed for the forms. Forms made to fit a special building may cost several times as much as those with which a standard building might be made. The cost of centerings may be reduced about in proportion to the standardization of the building. Many useful schemes for systematizing the general construction of centerings have been invented, and many of these have simplified the problem so that the main cost is in taking down and putting up the forms.

Most of these centering schemes are used for rough concrete work, where the surface is to be plastered afterward; but when finished surfaces are to be produced, the cost of centers is more than doubled. If the mechanic trained to do finished-center work be told to make rough standard centers, he will spend nearly 7½ hours carefully getting ready to do work which would take the other man ½ hour; conversely, the rapid standard-center man if put on perfect-center work would do in hour what would take the perfect center man about 7½ hours to undo and do over again. False conceptions and misrepresentations on the part of competitors in concrete work have led them into bitter warfare by presenting owners with what they term "finished surface" free of cost. Is it not possible to conceive a method of trying uniformly rough surfaces instead of uniformly smooth surfaces, as a help toward solving the problem of centers?

---

*Extract from a discussion by Guy B. Waite on "The Reinforced Concrete McGraw Building," Proceedings American Society of Civil Engineers, January, 1908, p. 52

The indirect method may be used to cheapen centers, that is, constructions may be used which do not require the expensive centering necessary in ordinary forms of reinforced concrete. If such constructions do not advance the total cost by increases in other directions, there will be a net saving. As is evident, the forms or centers for ordinary reinforced concrete must be sufficiently heavy to maintain a perfectly independent structure under the tendency to warp and deflect, due to the fact that they are alternately wet and dry, and also on account of the heavy load of the concrete. Where a steel skeleton, such as the columns in the McGraw building (Eng.-Contr., Dec. 19, 1906), maintains the construction lines, one may use for centers material which is much lighter, and more easily worked and handled than with ordinary reinforced concrete.

Steel Centers and Lagging for Constructing Concrete Lining for Tunnels.

The steel centers and lagging shown by the accompanying cuts were developed some seven years ago by Mr. Geo. W. Jackson for constructing the concrete lining for the network of tunnels built for the Illinois Telephone & Telegraph Co., at Chicago, Ill. Subsequently the same contractor has used this style of centering in constructing many thousands of feet of telephone, water-works and sewer tunnels. The drawing Fig. 1 shows the center rib for one of the water-works tunnels, the 8-ft. circular tunnel known as the Blue Island Land Tunnel for the water supply of Chicago. The lagging shown by Fig. 2 is practically standard for all sections of tunnel.

The ribs are made of channels in four segments jointed together by rivetted angle lugs. The top and bottom joints, it will be noted, are on a bevel to reduce the chance of binding in taking apart. A cross strut or chord strut braces the two lower segments apart. The rib channels are set up with their flanges projecting outward, so that, as will be seen from Fig. 2, the end angles of the laggings hook over the flanges and lock ribs and lagging firmly together. Each panel of centering, it will be seen, is independent and self-contained, so that the centering is composed of approximately 3-ft. units, the parts of which are of such dimensions and weights that they can be readily handled by men in confined spaces.

In operation the floor concrete is put in first and brought to grade at the center. Then the two invert segments of the ribs are set up and the invert concreted behind the lagging units placed one at a time. The arch segments are then erected and the concreting completed, working up the arch from both sides by placing the lagging units one at a time. In practice instead of making at A and B the tight joint shown by Fig. 1, the arch ribs are made about an inch short at each end of the half circle and the space taken up by wooden wedges between the angles; these wedges can be driven out in striking the centers, allowing the ribs to drop free from the roof. The last or the crown lagging unit is concreted over the end.

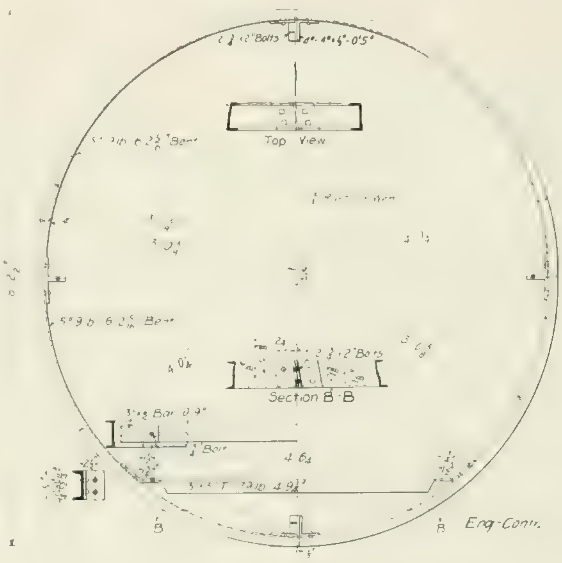


Fig. 1—Steel Ribs for Tunnel Centers.

This centering has several distinct advantages which are well worth investigating by contractors. It gives a particularly good inside surface. For tunnels up to 12 to 15 ft. diameters the stiffness of the channel ribs is ample to maintain the shape without cross bracing, and this leaves a free bore for material cars and for construction work. The centering units are small enough, 3 ft., to enable the lining to be kept as close to the face as is ever necessary; also the component parts of each unit are small enough to be easily erected, taken down and carried ahead. The life of the ribs and lagging is great and the various units are so simple and sturdy that damage is small and repairs are easy. The idea is of course to use the centering over and over, taking it down at the rear and erecting it ahead as the work advances. Knowing his daily progress and the time which the centers must stand before removal the contractor can readily figure the length of centering necessary to keep the work going.

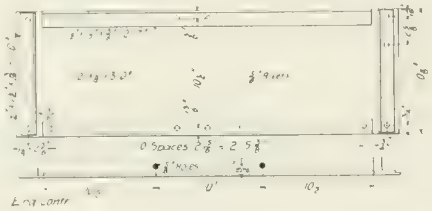


Fig. 2—Steel Lagging for Tunnel Centers.

Up to the present time Mr. Jackson has used this centering solely in his own tunnel work, but he has now made arrangements by which he will build it to the size and section desired and lease it to contractors at a cost which will give a saving over wood centers. The centering is patented by Geo. W. Jackson, Inc., Chicago, Ill.

The Department of the Landes, formerly the most miasmic and barren department in France, has, by the intelligent cultivation of pine forests, been changed into one of the richest, most productive and healthful sections of that country. Prior to 1803, the 2,500,000 acres comprised in the department, were little more than shifting sand dunes and marshes. The pine forests have changed all this. In the care of these forests the trees destined for "short life" are bled as soon as they are big enough to stand bleeding, when they have a circumference of a foot or 15 ins., the sapping of young trees being the only production of a new forest for a time, and when the "thinning out" time comes they are "bled to death," and the timber used largely for pit props, the English demand guaranteeing a steady and profitable market. The "standing trees," those giving promise of most vigor, are never tapped until they are about 3 ft. in circumference. When these have reached the age of 50 or 60 years they are cut down, and utilized for telegraph poles, railways ties, etc. To prevent the spread of forest fires, wide trenches are dug about limited areas, and the space kept clear.

There are 52,000 miles of railway in Asia.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Cost Data on Earth Excavation and on Rubble Masonry and Methods of Recording the Same.

BY C. A. SAWYER, JR.*

The extent of the work to be described was not large, yet it was sufficiently prolonged to enable the writer to obtain reliable costs.

Relative to this subject of cost data, it is possible to analyze unit costs which depend upon day labor and teams still further, in order that the information may be quickly interpreted and applied to his own work by the busy engineer or contractor. Take for example an itemized cost analysis, in which lost team time costs $0.06 per cu. yd. of material place measure, and hauling same a certain distance costs $0.30. These figures must be changed to the wage rate per hour paid in a certain location before a direct comparison can be made. Ordinarily this is done by proportion after finding the wage rate per hour for the labor or teams in the published data. Then by dividing the cost of hauling by the length of haul in hundreds of feet, the cost per 100 ft. of haul is obtained.

All this takes time, and, where search must be made through an entire article for the necessary information, the chances of error are multiplied. For this reason, we have based a system on the amount of time in hours, or decimal parts thereof, necessary for one man or one team to do a unit amount of work. This time period at once becomes a factor in the unit cost, the other factor being the wage rate per hour, of man or team. Calling the time factor the wage rate coefficient, and, designating the wage rate per hour by the letter R, a form of cost data is obtained which is adapted for quick comparison. In the above example, assuming the wage rate per hour for teams to be $0.60, and the capacity of each team to be one cubic yard place measure, the lost team time is $0.06 ÷ $0.60 = 0.1 hour, or 6 minutes. For universal application, the quantity 0.1 R gives the desired information. Assuming the haul to have been 2,000 ft., the cost per one hundred feet is $0.015. At the wage rate per hour of $0.60, this shows the time consumed to be 1.5 mins. As in the cost calculation of lost time, the cost per hundred feet of haul can be written (1.5 ÷ 60) R, or 0.025 R. Although the efficiencies of no two gangs are exactly the same and as one kind of labor differs from another, the actual time used to do a definite amount of work is shown at once by this method of carrying out the cost analysis.

The following comparison of costs in the above example with those given by Gillette on page 84 of his Handbook of Cost Data, shows the value of wage rate coefficients in determining relative amounts of work done:

	Gillette.	Special Case.
Team	2 horse dump-wagon	2 horse tip-cart
Capacity	1 cu. yd.	1 cu. yd.
Wage rate per hour	$0.35	$0.60
Cost—Lost team time (loading and dumping)	0.04	0.06
Cost per 100 ft. of haul	0.005	.015
Wage rate coef. Lost team time	0.114	0.10
Wage rate coef. per 100 ft. of haul	0.014	0.025

Comparing the wage rate coefficients, it is seen at once that the work of teams in the special case shows a saving of 12 per cent in lost team time, and that the hauling takes 80 per cent more time than Gillette's figure. At this point we are ready to ask why the lost team time was less and the cost of hauling more in the special case. In this connection are now to be considered the kinds of carts, stock, foreman and labor, as well as kind of material loaded, condition and grade of roads, time of year, general locality, etc. In like manner the work of bricklayers, stone masons, and other kinds of labor can be compared.

To illustrate the use of this system further, a column giving wage rate coefficients is added to the following data.

Below are records showing cost of excavation for and construction of a 25 ft. x 18 ft. fieldstone rubble foundation in a small town in eastern Massachusetts. The location was on a hillside having a 1 to 4 slope, approached by a road 40 ft. long x 8 ft. wide from the street to the lower side of the foundation.

Size of excavation—26 ft. long x 22 ft. wide x 12.8 ft. deep.

No. cu. yds. in above—271.

Soil—12 ins. brown loam with many stumps.

Sub soil—brown hardpan containing stones and bowlders.

Labor—Italian.

No. of men—8 to 9.

Working day—9 hours.

Teams—one-horse two-wheel tip-carts, capacity ⅓ cu. yd.

No. of teams—3.

Average haul—1,100 ft. from center of excavation to center of dump.

Time of year—December.

Each of the three drivers helped to load his own team, dumping same and leveling off at the fill. For this reason the total time of one driver is placed under cost of excavation. The itemized costs of picking, loading, hauling, dumping and leveling off were:

	Total.	Per cu. yd
Labor, picking, loading 687 hrs. at 0.20	$137.40	.507
Hauling, etc., horses 243 hrs at 0.25	60.75	.224
Hauling, drivers 162 hrs. at 0.20	32.40	.119
Totals	$230.55	.850

Lost team time averaged 15 mins. per cu. yd. This is greater than usual, due to cramped working space. Of the total cost of hauling ($0.343), $0.10 is for lost team time, and $0.243 for actual hauling time. This $0.243 is equivalent to $0.022 per 100 ft. of haul under the above conditions.

For universal application, the unit costs per cubic yard place measure would be:

Labor, picking and loading	2.5 R.
Single teams—lost time	.26 R′
Per 100 ft. of haul	.057 R′

in which the numerical part of the costs is the wage rate coefficient or number of hours or parts of an hour necessary to do the work described, R and R′ being respective wage rates per hour into which terms it is desired to change for comparison the data given.

FIELDSTONE RUBBLE MASONRY.

The masonry consisted of 84.9 lin. ft. of 18-in. foundation wall 13.4 ft. high, and two road walls of the same thickness 41.5 ft. long and 4.2 ft. high, making 82.6 cu. yds.

The itemized cost of labor and material used in building foundations were:

		Total.	Per cu yd.	Per cent of whole.	Wage Rate Coef.
Masons 352 hrs., at	$0.60 =	$211.20	$2.56	38.9	4.3
Helpers, 456 hrs., at	0.30 =	136.80	1.66	25.3	5.5
Stone, 82.6 cu. yds., at	1.00 =	82.60	1.00	15.2	
Cement, 42 bbls., at	2.25 =	94.50	1.14	17.3	
Sand, 18 cu yds., at	1.00	18.00	0.22	03.3	
	Total.	$543.10	$6.58	100.0	

Assuming 2.5 bbls. cement to 1 cu. yd. of 1-3 mortar, the 82.6 cu. yds. of masonry are found to contain 16.8 cu. yds. of mortar, which is 20.3 per cent of the total amount of wall laid.

This is an example of winter work in a district where labor and materials were high. The fieldstone used in the masonry was from cocoanut to one-man stone, laid carefully with many spalls to obtain a tight wall, as is shown by the small per cent of mortar used and which very closely shows the per cent of voids in the stone.

---

*General Contractor, 294 Washington St., Boston, Mass.

The Cost of Grading a Wagon Road in Winter.

In grading a railroad a section of a wagon road had to be built, and in order to carry on the railroad work the wagon road had to be graded during the winter months. The road was 2,800 ft. long and 30 ft. wide in the cuts, with a ditch on either side, 1 ft. deep, 1 ft. wide on the bottom, and 3 ft. across the top. The embankment was 26 ft. wide. There were 3,936 cu. yds. of excavation made from the cuts and borrow pits. The greatest depth of excavation was about 5 ft.; it averaged, in most places, about 3 ft.

The work was commenced during the last week of January, when the weather was fairly good, and the lightest grading work was done before the worst weather set in. A 10 hour day was worked, the following wages being paid:

Foremen	$2 50 and $ 3.00
Scraper team	4.75
Plow team 4 horses and 2 men	9.20
Snatch team, 3 horses and driver	6.00
Loaders	1.60
Laborers	1.50
Wagon teams	4.75
Road machine, 8 horses and 3 men	17.50

Two scraper gangs worked during January, and 1,194 cu. yds. were moved in 3 days. The cost of this was:

Foremen 6 days at $3.00	$ 18.00
Scrapers 45 days at $4.75	213.75
Plowing 3 days at $9.20	27.60
Snatch team 6 days at $6.00	36.00
Loaders 12 days at $1.60	19.20
Dumping 12 days at $1.50	18.00
Total	$332.55

The average haul on this yardage was 300 ft. The cost per cu. yd. for each item was as follows:

Foremen	$0.015
Scrapers	0.170
Plowing	0.023
Snatching	0.030
Loading	0.016
Dumping	0.015
Total	$0.278

With the wages paid, and for scraper work in January, this was a reasonable cost. The cost of plowing was low, about half of what it would have been had two plows been used, but one plow team did the loosening for the two gangs. Each scraper moved 26½ cu. yds. per day.

While this work was going on, a foreman and crew of men were laying some 12 in. terra cotta drain pipes across the roadbed. Three such pipes were laid, aggregating 123 lin. ft., the work including the ditches for them, as well as some small details to take the water to and away from them. The cost of this work was:

Foreman 1 day	$ 2.50
Laborers 14½ days	21.75
Total	$24.25

This made a cost per lin. ft. of pipe of the following:

Foreman	$0.020
Laborers	0.175
Total	$0.195

The work was finished during February, but for 10 days of the 17 worked it was bitter cold and light falls of snow occurred. The ground froze to the depth of a foot and the work was more expensive than that done in January. One scraper gang worked, the cost of it being as follows:

Foreman 16.8 days	$ 50.40
Scrapers 131.4 days	624.15
Plowing 16.8 days	154.56
Snatch team 16.8 days	100.80
Loaders 33.6 days	53.76
Dumps 33.6 days	50.40
Total	$1,034.07

The yardage moved during this time was 2,539, the average haul being 350 ft. Each scraper moved about 19 cu. yds. per day.

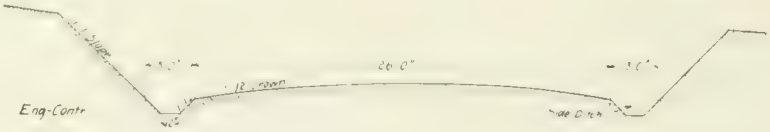


Fig. 1—Cross-section of Road as Built.

The cost per cu. yd. for each item was:

Foreman	$0.019
Scrapers	0.245
Plowing	0.060
Snatching	0.021
Dumping	0.020
Total	$0.405

In addition to this cost, the ground for a number of days had to be thawed, and two days of the coldest weather the teams could not work. Wood was used to thaw the ground, the wood being cut on the right of way, thus saving the price of stumpage to the contractor. It was hauled in dump wagons; each wagon hauled about ½ a cord per load, and made four loads per day, making a total of 2 cords per wagon day. A crew of men cut the wood and loaded it on the wagons. Two men built the fires and maintained them. In all about 28 cords of wood were used for the thawing. The fires were built in long windrows, and, as soon as the ground was somewhat thawed, the ashes of the fires were shoveled to one side, and a fire built up in another windrow. While this was burning up, a four-horse plow team with a pick pointed rooter plow, broke up the ground that had been thawed. This material broke up into clods which were hard to load into the scrapers. The plow point was broken frequently, and an extra one was kept in the tool box to replace it.

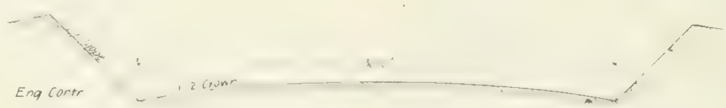


Fig. 2—Cross-section of Road as It Should Have Been Built.

After the foot of frost was loosened and excavated, the plowing was done by a heavy railroad plow. At night, before stopping work, the entire excavation was plowed over nearly a foot deep; this prevented the ground from freezing so solid during the night that the rooter plow could not loosen it the next morning.

The cost of cutting and hauling the wood, and maintaining the fires was:

Wagons 14 days	$66.50
Laborers 21 days	31.50
Total	$98.00

This cost must be added to the other. Distributed over the total yardage moved during the month this makes an additional cost of 3.8 cts., giving a total cost of 44.3 cts. per cu. yd. Naturally, the extra cost owing to the frozen ground is not covered by this one item of 3.8 cts., for a comparison of the February itemized cost with that of January shows a difference of 12.7 cts. The cost of plowing is more than double that of January, owing to a great extent to the fact that during February the plow loosened ground for the one gang of scrapers only, while during January it worked for two gangs. The haul in February had been increased by 50 ft. Of the total difference in cost at least 13 cts. can be directly charged to the cold weather and freezing ground.

Of the ground actually thawed by the wood fires there were about 1,511 sq. yds. The cost of thawing this was about 6½ cts. per sq. yd. As the frost penetrated the ground about one foot this meant that 503 cu. yds. of earth had to be thawed, at a cost of 19 cts. per cu. yd. The material was a red sandy clay. During the rest of the time, after the freeze, it was very muddy and difficult to handle.

Figure 1 shows a cross section of the road as it was actually built. The trimming and dressing outside of the ditches were done by a road machine immediately after the scrapers finished the work. Owing to the winter weather eight horses had to be used on the machine, and this meant an extra driver. The mud made the work difficult. The most of this was $43.75 for 2½ days' work. As the banks were 26 ft. wide, the total area dressed by the machine was 7,467 sq. yds., which gave a cost for trimming and dressing with the machine of 6/10 cts. per sq. yd. This cost distributed over the yardage moved, namely, 3,936 cu. yds., made 1.1 cts. per cu. yd.

After the weather had settled in the spring and the ground had dried, a force of men under a foreman was put to work cutting the ditches in the cuts. The cost of this was:

Foreman 4 days	$10.00
Laborers 37 days	55.00
Total	$65.50

From the ditches, 213 cu. yds. were excavated, which meant a cost of 30.7 cts. per cu. yd., and as there were 3,075 lin. ft. of ditch the cost per lineal foot was 2.1 cts. Distributed over the total yardage excavated, it gave a cost of 1.7 cts, making the total cost of trimming and dressing per cubic yard as follows:

Work with road machine	1.1 cts.
Work by hand	1.7 cts.
Total	2.8 cts.

This would also have increased the cost per sq. yd. more than 1 ct. If the cross section of the road had been as shown in Fig. 2, the road machine would have done all the dressing and trimming and the $65.50 could have been saved. This clearly demonstrates that the more economical design is that illustrated in Fig. 2. It must be remembered that the drainage can be amply cared for by the crown and the extra height of the metal.

The road was given a metal coat, supposedly 6 ins. thick, 16 ft. wide, of oyster shells. On account of the mud in some places the shells were much thicker. These shells, 12,300 bushels, were delivered at a wharf nearby on board of large scows, and were hauled in market wagons an average distance of 4,500 ft. The shells were loaded by scoop shovels, and the wagons had two holes cut in the bottoms. This allowed the shells to be dumped out of the end of the wagon and through the holes. One man with a large rake, a fork and a shovel spread the shells. The cost of this work was:

Foreman 5.8 days	$ 14.50
Wagons 45.3 days	215.17
Men loading 17.4 days	26.10
Man spreading 5.8 days	8.70
Total	$264.47

This made a cost for hauling and spreading of 11.5 cts. per bushel. The shells were only put on about 2,300 lin. ft. of the road, giving about 4,100 sq. yds. The shells cost 7 cts. per bushel delivered at the wharf. This gave a cost per sq. yd. of shells in place as follows:

Shells	21 cts.
Labor and hauling	11.5 cts.
Total	32.5 cts.

The shells were not rolled, but they were first placed on the road nearest the wharf, and the loaded and empty wagons hauled over them. As any holes developed, additional shells were placed in them.

The total cost of the work was as follows:

Scraper work	$1,366.62
Labor of laying drain pipe	24.25
123 lin. ft. 12 in. T. C. pipe at 30 cts.	36.90
Thawing ground	98.00
Road machine work	43.75
Ditching in cuts	65.50
12,300 bu. shells at 7 cts	861.00
Labor of placing shells	264.47
Total	$2,760.49

All of this work could have been done cheaper if it had not been the dead of winter. Even the shells could have been bought for 4 or 5 cts per bushel during the summer.

The Original Estimate of the Ashokan Reservoir Made by the Burr-Hering-Freeman Commission.

As throwing additional light upon the Ashokan reservoir bidding prices (see issues Feb. 12 and 19) we give herewith certain prices used by the "Burr-Hering-Freeman Commission" in its report to Mr. Robert Grier Monroe, Commissioner of Water Supply, Gas and Electricity, New York City, Nov. 30, 1903. This report was made in relation to the Ashokan Reservoir and it is interesting to note that the subsequent bidding prices of the John Pierce Co. were lower than the estimated prices of the Burr-Hering-Freeman Commission, particularly when it is remembered that Prof. Burr and Mr. Freeman have recently recommended the rejection of the John Peirce Co. bid because it was *too low* in its prices for earthwork.

Of course it should be remembered that the Burr-Hering-Freeman report was made four years ago, but at that time the 8-hour law was in existence and wages of laborers were substantially the same as they were last summer and autumn.

Before quoting from various pages of the Burr-Hering-Freeman report above referred to, we shall give a tabulated comparison of the estimated prices and the bid prices on the items over which there has been a dispute:

SUMMARY OF PRICES

	Estimate of the Burr-Hering-Freeman Commission.	John Peirce Co.'s Bid. (Rejected.)	McArthur Bros.' Bid. (Accepted.)
Earth excavation	$ .25 to $ .35	$ .30 to $ .35	$ .50 to $ .68
Core wall, earth excavation	1.00	.60 to 1.00	1.40 to 2.50
Embankment	.20 to .50	.35 to .50	.50 to .60
Rock excavation	1.25 to 2.50	1.25 to 2.50	1.00 to 3.00

Report, page 154. Estimates of cost of aqueduct work. Unit prices.

The following standard unit prices have been used in all aqueduct estimates, the rates being varied to suit local conditions of each section:

Earth excavation—From 35 cts per cu. yd. to 40 cts. per cu. yd.

Earth borrow—From 25 cts. per cu. yd. to 30 cts. per cu. yd.

Rock excavation—From $1.25 per cu. yd. to $2 per cu. yd.

Pages 163 to 165. In estimating the cost of aqueduct from Hibernia Reservoir to Billings Reservoir the following average costs have been used:

	Per Cu. Yd.
For earth excavation in canal	$ .30
For rehandling excavated material	.25
For rock excavation	1.50

Pages 141-153. In estimating the cost of the Stormville Reservoir—main dam and two small dikes—the Billings Reservoir Dam, Hibernia Reservoir Dam, Silvernails Reservoir Dam and the Clinton Hollow Reservoir Dam the following prices for excavation and embankment were used:

Earth excavation—	Per Cu. Yd.
Stripping dam base	$ .25
Trench for core wall	1.00
Wing wall, waste weir gate house, channel, etc.	.35
Rock Excavation—	
Core wall trench	2.50
Wing walls, waste weir, etc	1.50
Embankment—	
Embankment	.40
Excavating soil and depositing it in embankments, average haul 1,200 feet	.25
Excavating soil and hauling same 7,000 feet to shallow flowage bank	.35

Pages 181 to 184. In a detailed approximate estimate of the cost of Ashokan Reservoir the following prices are used:

Earthwork—	Per Cu. Yd.
Stripping entire reservoir	$ .30
Embankment selected material for dikes (spoil bank not included)	.40
Embankment for road crossings	.20

Channel excavation—

Base 15 ft. wide, assuming one-third loose rock, one-third rock and one-third earth. rock, $2; loose rock, 65 cts.; earth, 35 cts.

Pages 190 to 195. In giving detailed estimates of smaller reservoirs in the Esopus, Rondout, Schoharie and Catskill valleys the following prices are used:

	Per Cu. Yd.
Stripping	$ .30
Earth excavation	.30
Rock excavation	1.50
Earth embankment	.50

Shipments of yellow pine lumber from eight southern and southwestern states for 1907 was 3,001,084 M ft.

Unclassified and General Articles

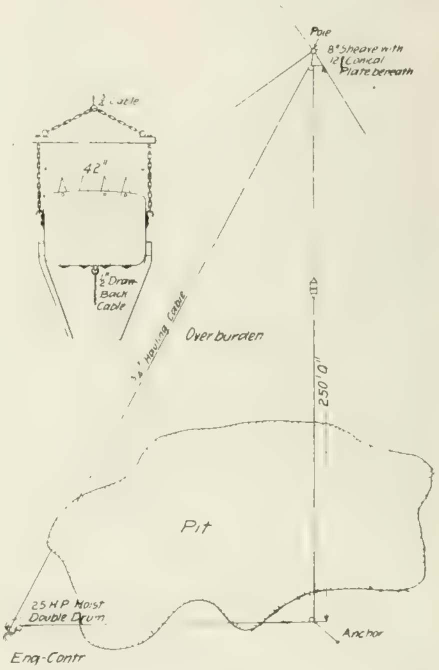
Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Methods and Costs; Some Old, Some New.

Road Treatment with Oil.—The roads about the factories of the Pope Motor Car Co., of Toledo, O., are made principally of crushed rock, which is very soft and rapidly disintegrates. As a means to lay the dust and make the roads waterproof, the company has been applying oil. Ordinary Ohio fuel oil is used by the company in its drop forge department for heating the steel, and in the course of time it was found that there was an accumulation of thick residue which could not be used for fuel purposes. This residue was used in treating an experimental piece of road. A short stretch of heavily traveled road was selected, the loose stones and refuse cleaned off, and the surface liberally sprinkled with this residue from the oil tanks, an ordinary watering pot with the holes enlarged being used in applying the oil. The experiment was very successful, but it was found that one application was not enough, as the tendency for the horses' hoofs and automobile wheels was to cut up the oil surface. A second and finally a third sprinkling were therefore tried. This seemed to answer the purpose, and the oil has soaked into the road surface, making an elastic, waterproof coating which absolutely prevents the giving off of dust, and when the road is used and any of the surface is cut up by horses' shoes, subsequent passage of vehicles will roll it down into place. Roads coated about Aug. 1 last answered very well up until the time that there began to be frost in the ground, when the oil surface was torn up, allowing the water to soak in more or less, so that the roads at present are covered with an inch or two of greasy mud. It is not expected, however, that this will cause any trouble, for as soon as the sun comes out and the roads dry up they will go back to their previous condition. If these roads had not been oiled, they would have been badly cut up at this time. The cost of the work in this case was simply the cost of the unskilled labor required to apply the oil. For the above information we are indebted to Mr. F. C. Gilbert, Sales Manager, Pope Motor Co.

Replacing Broken Cross Wires in Field Instruments.—The only tools required in this work are a pair of dividers, or a 6-in. piece of copper or soft iron wire bent to a U; in a pinch a forked stick will answer. The dividers have a small piece of beeswax pressed around their ends to hold the spider's web. In addition a small bottle of shellac dissolved in alcohol (a thin solution preferably) and a cocoon of spider web are needed. A couple of small pointed sticks will also come in handy. In putting in the new cross wires, the eyepiece slide of the instrument is unscrewed and removed without disturbing the object glass. The two opposite capstan-headed screws of the four which hold the cross wire ring in its cell are taken out and the other two screws are loosened. Using the latter as handles, revolve the ring 90 degrees and insert one of the pointed sticks through the end of the telescope tube into a screw hole; then using the stick as a handle, remove the other screws and take out the ring. All old shellac or dirt should be cleaned from the lines of the reticle ring and the latter placed with the marked side up. An inch or two of single web is then drawn out from the cocoon, and attached to the ends of the dividers by means of the beeswax. In case a forked stick is used the web is wound round the ends and fastened with shellac. The web should be carefully examined for defects with a pocket magnifier. If found satisfactory the web is moistened by dipping in water for a few seconds or by breathing gently on it. As the wet web lengthens the slack should be taken up by opening the dividers; no attempt should be made to stretch the web more than 1-16 in. from its original dry length. The web, still on its holder, is then carefully placed over the reticle, and moved about until it falls exactly in the center of two opposite lines; a magnifying glass should be used to insure accuracy. A small portion of the liquid shellac is then put over each side of the web about 1-16 in. from the central opening of the reticle and left undisturbed until the shellac hardens. After all the required webs are set, the reticle is replaced in the telescope by reversing the method employed in removing it. When in place the cross wires should be on the side of the rig toward the eyepiece.

Steam Scraper Work.—In the Klondike steam scrapers are often used in handling tailings from the creek-mining operations. The ordinary steam scraper outfit used in operations on tailings consists of a scraper of from ⅓ to ½ cu. yd. capacity, operated by a double drum, 2-cylinder hoist, of 25 to 30 HP. This outfit handles on an average 250 cu. yds. of loose material in 24 hours at an average cost of 49 cts. per cubic yard. In explanation of this high cost it may be stated that the wages of laborers are about $5 per day with board, or $8 without board; that bituminous coal at Nome costs $17 per short ton, and that spruce wood for fuel costs about $12 per cord. The scrapers drag the material from the pit to the dump, a horizontal distance of from 100 to 300 ft. and a vertical distance of 20 to 50 ft. The gang employed usually consists of three to four men—a fireman, a hoistman and either one or two men to fill, guide and dump the scraper. The form and rigging up of the scrapers and the system of sheaves and drawback usually employed are shown in the accompanying figure. Toothed scrapers, like the one shown in the cut, are not always used, but are preferred. An adaptation of one of these plants was used in stripping loam in excavating for a reservoir at Portland, Ore. In this case a bottomless scraper was used. The scraper had a theoretical capacity of 6 yds., but actually handled about 3 yds. In the work in seven 10-hour days, stripping to 4 ft. in depth, 400 cu. yds. per shift were handled by the outfit. Furrows 300 ft. long were made by the scraper. A 60 HP. boiler was used but only one cord of wood at $2 was burned per day. A double drum hoist, provided with 10 x 12-in cylinders and geared 6 to 1, was used. The gang consisted of a winchman, a fireman, and two scraper men, at $2.50 per day. Under these considerations the operations were said to cost about 5 cts. per cubic yard.



Sketch Showing Arrangement in Steam Scraper Work.

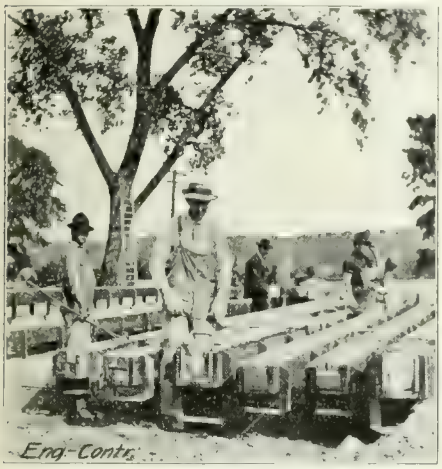
Building permits totaling $580,492,196 in value were granted in the larger cities of the United States in 1907.

LETTERS TO THE EDITORS.

Some Additional Data on the Method and Cost of Constructing Reinforced Concrete Poles.

Sirs.—The prime factors in the construction of concrete poles are the materials forming the grout. This is true of all concrete construction, but particularly so in the construction of concrete poles, where the cross-section is small and the greatest possible tensile strength is desired. Unless the best quality of crushed stone and sand is used, desired results cannot be obtained. The accompanying cuts show the method of molding concrete poles on which these and the following remarks are based.

The steel reinforcing rods are placed 1 in. from the surface of the pole in 3 sets; four rods extend to the top of the pole, four rods two-thirds of the length of the pole and four rods one-third of the length. In testing the finished pole to destruction this distribution of the steel was found to be practical, giving a uniform stress from top to ground line. A 30-ft. pole with 6-in. top and 9-in. base deflected 3 ft. at the top from a plumb line, and straightened when the load was removed without any apparent damage to the pole. A 30-ft. pole must stand a strain of 2,500 ft. lbs. at the groundline. The feature to be reckoned with in the building of a line of concrete poles is the transportation and erection. A 30-ft. pole, with a 6-in. top, will weigh 2,000 lbs. It is a practical proposition to build this length pole in a yard, in forms on the ground. A pole of any greater length should be built in place, from the ground up, although I have erected 45-ft. poles that weighed 5,600 lbs. The 30-ft. reinforced concrete pole can be built in Chicago for $7.50 and erected with proper equipment for $1 each.



Finishing Poles at Yard.

The reinforced 30-ft. concrete pole with 6-in. top and 10-in. base, and corners chamfered to 1-in. radii contains ½ cu. yd. of concrete and 200 lbs. of steel, the cost being as follows:

200 lbs. of steel at $1.85 per 100 lbs.	$3.70
½ cu. yd. concrete at $7.50 per yd.	3.75
Total	$7.45

The estimate of the cost of the finished pole is based on the following prices: Crushed stone $1.25 per cu. yd., sand $1.10 per cu. yd., cement $1.75 per barrel, and labor 20 cts. per hour. In erecting concrete poles, the equipment will vary to suit the conditions. On traction lines, where the poles are close to the track, the most convenient method of erection is to rig a hinged stiff-leg derrick on a flat car, with a boom of sufficient length to pick up poles on cars at either end of the derrick car. This derrick should be hinged so as to be conveniently lowered to pass under grade-crossings and obstructions of any nature. On steam railway construction, where the pole line is often 60 to 70 ft. from the track, a derrick truck with jack-arms is used in the same manner as the car, picking up the delivered poles from the ground instead of from the car.

Yours very truly,

F. J. Hunt.

Richmond, Ind., Feb. 14, 1908.

Methods and Cost of Excavating Sewer Trench with Steam Shovels.

Sirs: Can you refer me to any data regarding the use of steam shovels for excavating sewer trenches? I desire to know the method of mounting and moving shovels on such work and, particularly, to obtain data regarding the operating cost.

Very truly yours,

"Engineer."

Chicago, Ill., Jan. 20, 1908.

(We know of very few published data on the cost of this class of work. Trenches from 4 to 10 ft. wide and from 15 to 18 ft. deep can readily be dug with a small steam shovel that has a long dipper arm substituted for the regular size arm. A light shovel, like the Little Giant shovel manufactured by the Vulcan Iron Works, Toledo, O., can readily be taken off the trucks and mounted on skids; a shovel of this weight will be found easy to handle on rollers and to require less shoring to maintain the trench than a heavier shovel. A steam shovel of this size can be counted upon to excavate from 400 to 500 cu. yds. under favorable conditions in digging in a bank, but in working in a sewer trench much less work will be done. The narrowness of the trench is a limiting factor, as is also the depth. We know of one contractor who, in digging an 18-ft. trench for a 12-ft. sewer, has averaged between 350 and 400 cu. yds. per 10-hour day; part of the material was dumped alongside the trench and part was loaded into wagons and hauled away. The material dumped on the ground was put on one side of the trench and the other side was reserved for the loading of wagons. The timber gang worked in front of and under the shovel, shoring the sides. The crew for the work consists of about the regular crew worked on shovels of this size; namely, engineer, fireman, craneman and four laborers. One foreman can look after both the shovel and the shoring gangs. In an 8 ft. trench the output would be less than in a 12-ft. trench; 10 per cent would, perhaps, be a fair reduction. In regard to shoring, it may be said, that if the work is in the country, shoring can be done away with and money actually saved by excavating a slope on the sides, the few yards extra excavation being less costly than timber work. In addition to the above general information, based on a knowledge by the editors of several jobs, we can also give briefly some observations made by Mr. Geo. E. Zimmermann, Contractor, Milwaukee, Wis., who has used a Vulcan shovel for sewer work for some five years. Mr. Zimmermann states that a shovel pays best on wide trenches, say from 4 to 10 ft.; for narrow and shallow trenches there are other machines which will do the work cheaper. He uses a Buckeye Traction Ditcher for pipe sewers and water main work. For hard clay and boulders the steam shovel is the best of all machines. Mr. Zimmermann does not remove the traction wheels from his shovel; when a shovel will be worked for months on a large job, without moving to another job, it is all right to remove the wheels and mount the shovel on a scow or skids, but when the shovel is moved frequently from one job to another, the cost of moving on skids or changing from skids to wheels and back again is too expensive. To use the shovel on wheels he constructs a track of 6 x 8 in. x 6 ft. timbers as follows: Oak timbers of 6 x 8 in. x 16 ft. are laid across the trench. Two timbers laid side by side and breaking joints form each "rail" of the track. It requires about 40 cross-timbers so as not to delay operations. As the shovel advances about 8 ft. each move, the pit men can carry about eight cross-timbers from behind the shovel and pile them across the trench just ahead of the shovel, whence they can be quickly distributed when it comes time for another move. With this method the working force consists of—

View of 45-ft. Pole.

The weight of this pole was 5,500 lbs and its cost in place was $17.50.

1 craneman, at $3.50	$ 3.50
1 engineer, at $5	5.00

4 laborers, at $3	12.00
Coal, per day	3.00
Total, per day	$23.50

Four laborers are necessary to keep the trench shored so as not to delay moving ahead. About one-half the time during the day is required for shoring and moving ahead. Regarding the cost of digging, Mr. Zimmermann states that it depends on the nature of the ground. He has dug an 8 x 14 ft. trench, 2,200 ft. long, at an average cost of 38 cts. per lin. ft. To dig the same trench by hand, he figures, would have cost $2.50 per lin. ft. Mr. Zimmermann uses two dippers on his shovel, one for narrow trenches about 30 ins. wide and another for wide trenches.

The preceding figures, while quite general in character, will give our correspondent some of the information that he is seeking. We should be glad to have further data from any of our readers who have experience in this line of work.—Editors.)

The Chilean Congress has passed a bill authorizing the president to make contracts for a railroad running north and south. The bill limits immediate expenditure to about $37,500,000, but it is intended eventually to extend the line to the northern and southern frontiers.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0595—**Concrete Block Machine.**—A. G. Boos, Jackson, Mich.

The machine described in this 64-page pamphlet is of the face-down type. This permits the mortar facing to be tamped directly on the face plate. These face plates are made in plain paneled forms and also in ornamental forms of various patterns. The pamphlet describes the construction and operation of the machine, tells how blocks are made with it, and gives a large number of illustrations of separate blocks and of concrete block buildings.

No. 0596—**Dragon Portland Cement.**—The Lawrence Cement Co., 1 Broadway, New York.

This 126-page pamphlet has been gotten up with exceeding care and gives an excellent account of the properties of this well-known cement and of the many structures in which it has been employed. There is an introductory section describing the quarries and the process of manufacturing Dragon cement, followed by rules for testing cement, for mixing and placing concrete and for various other parts of cement and concrete work. The illustrations are handsomely printed and show a large number of important structures. There is also a large number of testimonial letters from engineers and architects who have used this cement.

No. 0597—**Concrete Mixers.**—Koehring Machine Co., Milwaukee, Wis.

The mixer described in this pamphlet is of the non-tilting type and is furnished either with or without automatic loading bucket. A separate machine for street work in which the discharge is handled by conveyor and disposed directly in place is also described and illustrated. Tables of sizes and capacities are given and all the other usual catalog information. The mixer is an interesting one and the catalog is well worth securing.

No. 0598—**"Two in One" Hoisting Drum.**—The Hayward Co., New York.

This pamphlet is devoted to a description of the "Two in One" drum which has recently been put on the market by the above company. Briefly described the device consists of two drums mounted on the same bed plate and acting as one drum. This drum can be used on dredges, excavators, traveling derricks, guy and stiff leg derricks, locomotive cranes and in fact almost every style of machine capable of operating an automatic bucket. The pamphlet is well worth securing by contractors.

No. 0599—**Gabriel System of Concrete Reinforcement.**—The Gabriel Concrete Reinforcement Co., Detroit, Mich.

This 118-page book is largely given up to a complete set of designing tables for the system of reinforcement named above. The Gabriel bar is a trussed bar which is placed in the forms as a unit. This book discusses the formulas used in designing beams and columns and gives a complete set of tables for columns, floor-slabs and girders. The tables have been very carefully gotten up and are quite complete and should be of use to engineers engaged in designing reinforced concrete structures.

No. 0600—**Vault Lights.**—Albert Grauer & Co., Detroit, Mich.

The Vault Lights described in this 36-page pamphlet consists of a reinforced concrete rack or grid which supports the prisms. Complete details of construction are given with records of strength tests and a discussion showing the illuminating value of the special prisms used. The pamphlet is well printed and illustrated and will be of use to engineers.

No. 0601—**Locomotives.**—Baldwin Locomotive Works, Philadelphia, Pa.

This 32-page pamphlet describes in a very complete manner the locomotives which this company has built for the Central Railroad of Brazil. The history of this railroad and of the development of the special type of locomotives designed for it is very interesting and the pamphlet is well worth reading.

No. 0602—**Steel Tires.** — Standard Steel Works Co., Philadelphia, Pa.

This 38-page pamphlet contains a reprint of a paper on "Steel Tires—Causes of Defects and Failures," read by George L. Norris, before the Western Railroad Club on October 17, 1907. The paper is one of the most complete that has been presented on this subject, and the company above named has published it in excellent shape with halftone illustrations and all the necessary typographical care necessary to bring out the full force of the picture defects shown. The pamphlet is well worth securing by railway engineers and motive power officials.

No. 0603—**Concrete Mixers.**—The Hartwick Machine Co., Jackson, Mich.

The Mixer described in this pamphlet is known as the Scheiffler Proportioning Mixer. It is a mixer of the continuous type provided with mechanism for feeding and proportioning the concrete materials. The pamphlet describes and illustrates the construction and operation of the mixer and gives dimensions and details of the various sizes and capacities.

No. 0604—**Bacterial Sewage Filters.**—Pacific Flush Tank Co., Chicago.

The object of this 52-page pamphlet is to show the application of the automatic apparatus manufactured by the above named company to various types of bacterial sewage filters. To accomplish this purpose the pamphlet illustrates a number of disposal plants designed by engineers and equipped with the apparatus specified. These plans are very well worked out and should be of interest to city engineers.

No. 0605—**Engineers' Instruments.**—F. W. Devoe & C. T. Raynolds, New York City.

This 336-page catalog gives prices and other catalog data regarding the full line of artists' materials manufactured by the company named. Besides artists' materials the company manufactures a full line of instruments and materials for mechanical draftsmen. Practically every form of instrument and all kinds of materials used by both artist and draftsmen are listed in this catalog. It should be of use for the files of drafting offices.

Personals.

Col. Augustus Pruyn, a retired civil engineer, died recently at his home in Albany, N. Y., aged 77 years.

Mr. Hugh Bonner has been appointed Fire Commissioner of New York City, succeeding Mr. Francis J. Lantry, resigned.

Mr. Philip J. Nash has taken charge of the Sales Department in Chicago, of the Ernst Wiener Co. of New York. The Chicago offices are located in No. 863 Monadnock Bldg.

Mr. S. Bent Russell, M. Am. Soc. C. E., Consulting Engineer, of St. Louis, Mo., has been appointed Chief Engineer and Superintendent of the Water Works of Louisville, Ky.

Mr. A. Bement, Member of the Board of Consulting Engineers of the Smoke Abatement Commission of Chicago, Ill., has been appointed by the Illinois Coal Operators' Association a member of its Coal Stoking and Anti-Smoke Committee.

Mr. J. M. Dorrance and Mr. F. N. Drane have been elected Directors of the Fred A. Jones Construction Co. of Houston, Tex. The company is now building an interurban line between Dallas and Sherman, Tex.

Messrs. G. N. Scherer, Henry C. Adams and Michael J. Quigley have organized the Southwestern Engineering & Construction Co., of Newark, N. J., for the purpose of constructing and operating railroads.

Mr. Charles R. Pease has been elected President of the Pease-Buzatt Construction Co., recently organized to engage in a general construction business. The headquarters of the company will be at Indianapolis, Ind.

The firm of Graves & Stephens, Public Works Contractors, Cleveland, O., has been dissolved by mutual consent. Mr. E. M. Graves has purchased the entire interest of Mr. D. C. Stephens in the business and assumed all its liabilities.

Mr. Allen N. Spooner, M. Am. Soc. C. E., has been appointed Dock Commissioner of the City of New York, to succeed Mr. John A. Bensell, M. Am. Soc. C. E., who was recently appointed Commissioner of the Board of Water Supply of the city.

The following officers were elected at the recent annual meeting of the Connecticut Society of Civil Engineers: President, Mr. Edward W. Bush, Hartford, Conn.; first vice President, Mr. F. J. Easterbrook, New Haven, Conn.; second vice President, Mr. Frederick H. Oldershaw, New Britain, Conn.; Secretary and Treasurer, Mr. J. Frederick Jackson, New Haven, Conn.

Willard A. Gray, Chief Engineer of the Milwaukee plant of the American Bridge Co., died recently at his home in Wanwatosa, Wis., aged 41 years. Mr. Gray entered the employ of the Milwaukee Iron & Bridge Co. (now the Milwaukee plant of the American Bridge Co.) in 1898. Previous to that he had been with the Clinton Bridge Co., of Clinton, Ia., and before that he was an assistant to his father, who was Chief Engineer of the Chicago & Alton R. R.

Mr. L. H. Taylor has resigned as Supervising Engineer in the U. S. Reclamation Service and has opened offices in the Chronicle Bldg., San Francisco, Cal., where he will engage in a consulting and general engineering practice. Mr. Taylor is still retained as Consulting Engineer by the U. S. Reclamation Service, but will devote the most of his time to private practice. Mr. Taylor had direct charge of the Truckee-Carson irrigation project in Nevada from its inception in 1902 until its completion in 1907.

Mr. Wynn Meredith, M. Am. Inst. E. E., has become a partner in the firm of Sanderson & Porter, Engineers and Contractors, and will have charge of the Western office which they have opened in the Union Trust Bldg., San Francisco. After a technical training at the University of Illinois, Mr. Meredith, in 1888, became engaged in the construction and operation of lighting and railway properties. He was actively connected with the engineering and operation of the electrical plant of the World's Fair at Chicago, in 1893, and the California Fair in 1894, subsequently becoming associated with Messrs. Hasson & Hunt, and later a member of the firm of Hunt, Dillman, Meredith & Allen, San Francisco, Cal. During 15 years' residence in California Mr. Meredith has been engaged in general engineering work and prominently identified with many of the important hydro-electric and transmission developments on the Pacific Coast, in the United States and Canada.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance).—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class matter April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

In a Lucid Interval Panama Canal Commission Awards Three Building Contracts 131
The Opening of the First Hudson River Tunnel.. 131
The Names of 650 Applicants for Membership in the American Society of Engineering Contractors..... 131

CONCRETE SECTION:

The Necessity of Continuity in the Steel Reinforcement of Concrete Structures.......... 134
Cost of Concrete Highway Bridges and Culverts in Greene County, Iowa... 136
Proposed Standard Tests for Concrete Building Blocks. 137

EARTH AND ROCK SECTION:

Comparison of the Cost of Wheel and Drag Scraper Excavation on a Job in Mississippi.... 138
Cost of Shaft Sinking in Goldfield...138
The Cost of Digging Some 600 Trolley Pole Holes..........139

ROADS AND STREETS SECTION:

Tables for Estimating the Quantity of Materials and Cost of Gravel Sand and Oil on Roads and Streets of Different Widths. 141
Suggestions Wanted for Uniform Street Specifications and Highway Practice 141
Object Lesson Roads Built in 1906-07 by U. S. Office of Public Roads, with Data on Their Cost..........142

GENERAL ARTICLES:

United States Reclamation Service General Specifications for Telephone Systems..........145
The Economics of Snow Removal and a Suggested Improvement Over the Present Methods Used in New York..........147

METHODS AND COSTS:

Blasting Ice—Preparing Road Subgrades—Cost of Drilling Test Holes—Preventing Sediment from Being Drawn Into Condenser Intakes—Transplanting Forest Trees........148

In a Lucid Interval the Panama Canal Commission Awards Three Building Contracts.

Three contracts for erecting buildings have just been awarded by the Panama Canal Commission. The "Canal Record" says:

"The future policy of the Commission as to continuing this method of building construction as a regular practice will depend upon the results obtained from these three contracts. It is the intention of the Commission to reduce the cost of buildings and if this result cannot be obtained by constructing buildings by day's labor, an effort will be made to do so by contract."

We fail to see the logic of the reasoning that leads the Commission to base its "future policy" in matters of this kind upon the results obtained from three small building contracts; particularly when every architect in America has learned that the *only* economic method of erecting buildings is by contract. We are gravely told, however, that the Commission is about to test the contract system of doing work. Perhaps we should be thankful for this slight symptom of returning sanity.

The Opening of the First Hudson River Tunnel.

The first tunnel under the Hudson River at New York City begun in November, 1874, was opened for traffic with formal ceremony on Tuesday, Feb. 25, just as the last preceding issue of this journal was going to press. Few engineering works have had such wide publicity given them as has this and few have had a history so full of vicissitudes. The Hudson River Tunnel Co. was incorporated in May, 1873, by De Witt C. Hurkin, a man of bold ideas and unbounded confidence in them, but dreaming little and knowing less of the task he had set himself in this case. In November, 1874, construction was begun on a double track tunnel 26 ft. wide and 24 ft. high in clear section. Hardly had the first shore shaft been started when an injunction suit stopped the work and it was not until Setember, 1879, that the litigation permitted the resumption of work. Then the plan was changed. Two tunnels 16 ft. wide and 18 ft. high were substituted for the single double track section and work was begun using compressed air without a shield. A brick lining 2 ft. thick was employed. When one tube had reached 280 ft. from the shaft and the other had just started, a blowout on July 21, 1880, filled the workings and drowned 20 men. The accident was repaired and work was resumed in January, 1881, using the pilot tube system devised by Mr. J. F. Anderson, superintendent of construction. Mr. Anderson resigned in April and in May, 1881, Gen. Wm. Ivvy Smith took charge remaining less than a year. In December, 1881, work was begun on a shaft at the New York end and work continued on the New Jersey end. In March, 1882, the New York shaft had been completed. In November, 1882, lack of money brought all work to a stop; the work then stood as follows: The New Jersey south tube was completed for 570 ft. and the north tube for 1,542 ft. and 74 ft. of the New York north tube was finished. By April, 1883, more funds had been raised and work was started again at the New York end only; by August the north tube at this end had been advanced to 150 ft. and the south tube to 20 ft., when work was stopped for lack of money. In April, 1887, more money having been got, work was resumed at the New Jersey end and by September the north tube had been completed for 1,840 ft. when work was again suspended. Then English capitalists and contractors took hold of the work resuming construction in March, 1889. A shield was built and cast iron lining was substituted; work was continued until August, 1891, when lack of funds again caused a shut down. By this time the New Jersey north tube was 3,916 ft. out. Foreclosure proceedings were brought and the tunnel was sold in 1899 being purchased by Stetson, Jennings & Russell for the bondholders. In 1902 the New York & New Jersey R. R. Co. resumed work with Mr. Charles M. Jacobs as chief engineer. From this time on work progressed without interruption, the north tube being holed through on March 11, 1904, and the south tube on Sept. 30, 1905.

The Names of 650 Applicants for Membership in the American Society of Engineering Contractors and the Objects of This Society.

We print herewith the names of 650 applicants for membership in the American Society of Engineering Contractors. The significance of this large number is perhaps best seen through comparison. When the American Society of Civil Engineers was founded, its charter members numbered but fifty.

Several hundred of the new readers of this journal may never have seen an editorial statement of the objects of the Am. Soc. Eng. Contrs., hence a brief summary of the character of this proposed society will again be given.

It is proposed to organize a national society to consist of contractors and of civil engineers. Perhaps the primary purpose of this society will be the bringing together of these two classes of men whose interests, although apparently divergent, are after all identical since their common object is the production of engineering structures in the most economic manner. Discussions of specifications will, therefore, form a prominent feature of the transactions of this society. At present it is rare that a specification is not vague or unfair in some one or more of its provisions. Disagreements

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

and law suits have been and are the natural fruitage of such documents. Aside from the waste of time and money arising from law suits, there are other and perhaps even more serious consequences that flow from disagreements between engineers and contractors. Among them may be mentioned the following:

(1) Fear of legal contests often leads engineers to condemn the contract system entirely, and to advocate the day labor system. No greater economic blunder could be made than to do public work by day labor, yet the tendency of engineers to advocate the day labor system is greatly strengthened by every legal contest and by every piece of trickery resorted to by contractors.

(2) Vague, harsh or unjust specifications tend to breed trickery among contractors, and often serve to prevent honest and capable contractors from bidding. Clear and complete specifications have the opposite effect.

While it is hard to exaggerate the importance of this subject of specifications, it should by no means cast into shadow the many other matters that will properly come before the proposed society. For example, there is no other organization of engineers or contractors that takes the slightest interest in politics, except, perhaps, some small bodies of local contractors. Yet who is better able to judge the merits of a proposed legislative act or of an ordinance bearing upon the construction of public works than is the engineer who will design the structure and the contractor who will build it? Bills and ordinances, without number, are passed that could be amended or defeated by any vigorous organization of contractors and engineers; and they would need to use no other weapon than publicity accompanied by their concerted protest. In many cities, counties and states the officers who award contracts for public works are men utterly without experience either as engineers or as contractors. Boards and commissions composed of politicians and alleged business men are in control of the executive machinery that runs most of our public works. They occupy places for which they are fitted by not so much as a thin plaster of experience over their cyclopean ignorance. Being ignorant of the works that they are supposed to control, they are obviously incapable of choosing the most suitable subordinates to perform the work. In consequence, great public projects have been so frequently underestimated as to cost, and so poorly handled as to policies of design and construction, that the wonder is that any appropriations for large public works can be secured at all. The latest example before us is the Panama Canal, now claimed by its chief engineer as having been undestimated by half, yet given over to the wasteful administration that invariably follows the doing of such work by the day labor system. Surely these are political matters that it will pay every contractor and every engineer to investigate and act upon. The American Society of Engineering Contractors is at present the only organization that is likely to effect immediate and substantial reforms in public policies relating to public works.

There is another field of activity for this society, and its acres cover the whole country. We mean the education of laborers and labor organizations to a full understanding of the principles of political economy that underlie any true and lasting prosperity of both employer and employee. The basic principle is this: *Great output of individuals results in great national prosperity, in which each individual eventually shares.*

The labor union that limits the daily output of its members, that makes it difficult for apprentices to enter the trade, that resists the bonus system of payment, and that fights against the use of labor saving methods or machines, is pursuing the same policy that triumphed in Asia and in India centuries ago, and foredoomed those countries to misery and want. Hindu caste is nothing else than modern labor union restriction of occupation and output carried to its logical conclusion.

The American Society of Engineering Contractors will start its corporate existence with a membership many fold larger than that had by any other society in the contracting or engineering field at its inception. With this evidence of its assured success before you, we urge again that you join. An application blank will be found on advertising page 18.

The list of names follows:

Abadie, E. H.
Adams, Harry C.
Ahlborn, Theodore
Allen, Wilton, O.
Alexander, Henry F.
Amerman, Melvin R.
Anderson, A. H.
Anderson, F. W.
Anderson, Harry W.
Andrew, I. A.
Andrews, Wm. M.
Andrews, W. P., Jr
Annan, J. P.
Antonisen, J.
Arnold, Walter T.
Asbjornsen, M. G.
Ash, Dorsey
Ashcroft, G. B.
Austin, S.

Baggott, C. W.
Bailey, J. W.
Balcomb, Jean Bart
Ballinger, R. E. C.
Balsley, E. A.
Bamford, W. B.
Barhorn, Frank A.
Barney, C. P.
Bartl, Edmund A.
Bartlett, Charles H.
Bartlett, C. L.
Bartlett & Kling
Bassett, H. M.
Baxter, D. E.
Bean, W. Worth
Beatty, J. E.
Beebe, J. W.
Beckman, Wm. Schuyler
Beet, John
Bell, Carlos H.
Bell, George F.
Belzner, Theodore
Benham, W. L.
Bennett, Charles N.
Bennett, James C.
Benson, J. A.
Benson, J. F.
Bent, Arthur S.
Bentzon, A.
Bernstein, Moriz
Berry, Leslie H.
Beugler, Hugo M.
Bierbaum, C. H.
Billings, A. W. K.
Bishop, Wm. Israel
Bixby, Lt. Col. W. H.
Black, John Cecil
Blackmer, Geo. G.
Blanchard, Arthur H.
Blinn, Ray S.
Blose, Ira F.
Bonner, Harry E.
Booker, S. E.
Bosch, Frank B.
Bowers, K. C.
Boyd, J. Leonard
Bradford, Geo. H.
Bradley, Clifton
Breckinridge, Caball
Brenn, C. F.
Brewster, Henry B.
Briddeel, G.
Brillhart, Jacob H.
Brooks, H. W.
Brotherton, D. A.
Brown, Chas. F.
Brown, Elmer W.
Brown, John G.
Bruce, J. M. & C.
Bryan, A.
Bryson, Thomas B.
Bumann, C. S.
Butcher, Joseph F.
Byers, Archibald F.

Calahane, James P.
Cameron, John B.
Campbell, Albert Park
Carter, H. H.
Carver, D. W.
Case, Benjamin H.
Castle, D. S.
Catlin, E. H.
Chandler, Elbert M.
Chase, Marvin
Chester, C. P.
Class, C. Frank
Clawiter, Edward I.
Clement, Harrison
Codd, C. E.
Coggan, C. J.
Cole, G. Percy
Cole, Howard J.
Coleman, John B.
Coleman, John F.
Coles, Chas. E. N.
Collins, G. A.
Collins, George C.
Collins, George H.
Coltman, Robert
Conrad, L. E.
Considine, Eugene F.
Cooney, Chas. F.
Coplan, A. C.
Corriveau, R. de B.
Corwin, W. B.
Cosgro, J. P.
Coupe, Alfred L.
Courter, Guy W.
Cowen, W. H.
Craven, J. T.
Crooks, John A.
Cryder, H. M.
Cummings, Robert A.
Cummins, Thomas R.
Cunningham, F. B.

Dailley, Joseph A.
Dailey, Daniel S.
Daris, Fred
Davis, C. S.
Dean, Bertram D.
DeKinder, J. J.
Dennis, Wm. F.
Des Granges, John C.
Detwiler, H. E.
D'Hemecourt, G. A.
Dickey, James
Donnelly, W. J.
Drukker, D. H.
Dykeman, Conrad F.

Eastman, S. P.
Eckhard, Christian
Edge, A. B.
Edmonds, A. Braxton
Edwards, Oliver C.
Ege, C. R.
Egleston, Howard
Ehlers, Paul H.
Elfreth, Harold D.
Elliott, L. B.
Ellsworth, A. W.
Elsea, R. H.
Elsemore, W. C.
Emerson, F. M.
Engel, B. N.
England, P. W.
Eppele, Frank J.
Erwin, Henry
Erwin, M. C.
Evans, George H.
Evans, Jos. D.
Eymes, Herman H.

Fairchild, C. D. V.
Faust, Frank C.
Fellows, A. L.
Ferguson, J. E.
Fillion, E. E.
Fisher, Fred
Fisher, Janon
Fitzgerald, P. S.
FitzRandolph, W. S.
Frixmer, Hugh J.
Flagler, J. M.
Flaherty, W. H.
Foley, John
Fonda, Arthur I.
Ford, P. D.
Fouilhoux, J. Andre
Fowler, Frank G.
Fox, Charles Kirby
Foye, Andrew E.
Francy, E. E.
Frazier, Thomas H.
Freeland, John A.
Freeman, George W.
French, C. J.
Frisbee, Jerome B.
Fritz, A. L. G.
Frost, George P.
Fuce, Edward O.
Fuller, Andrew D. Co.

Garretson, W. F.
George, H. M.
George, James Z.
Gibson, Harold H.
Gilbreth, Frank B.
Gilkison, W. D.
Gillette, Cassius E.
Gillette, Halbert P.
Gillette, Walter A.
Gilmour, A. J.
Gilmor, Harry
Girder, L. T.
Girth, Geo. C.
Gladding, James N.
Gloyd, James R.
Goerke, James F.
Goldie, E. C.
Grace, Richard J.
Grady, Walter J.
Granberry, J. H.
Gray, Henry L.
Greensfelder, A. P.
Grider, L. T.
Griffin, M. J.
Griffith, Geo. L.
Grimes, E. L.
Grimshaw, Wm. B.
Griswold, H. J.
Grontoft, A.
Grossart, L. J. H.
Gunn, James Newton
Gurin, P. M.
Guttridge, Jas. A.

Hall, Louis C.
Hallihan, J. P.
Hamilton, Charles F.
Hanks, Louis B.
Haring, Alexander
Harms, Henry J.
Harms, John
Harper, Fred C.
Harris, W. Francis
Harris, W. R.
Harris, W. R.
Harrison, H. L.
Harrop, John T.
Hart, A. L.
Hart, Reuben C.
Haskins, Wm. J.
Hauer, Daniel J.
Hawley, John C.
Hayden, Wm. H.
Hayne, U. G.
Hazen, W. B.
Hedden, E. B.
Hegardt, C. B.
Heiges, T. Tyrrell
Heller, H. E.
Heller, P. M.
Henderson, Herbert
Henry, A. R.
Hermans, Frank A.
Hewerdine, T. S.
Hicks, Hervey B.
Hicks, Lewis A.
Hill, Charles S.
Hill, F. L.
Hirst, S. M.
Hitchcock, F. C.
Hogue, Gilbert H.
Holler, John M.
Horn, F. C.
Horrigan, William James
Hortstmann, Edward, Jr.
Howard, J. W.
Howes, Benjamin A.
Howley Construction Co.
Hubbard, I. Wendell
Huber, F. A.
Humphrey, George R.
Hunt, Leigh
Hunter, H. G.
Hurst, George J.
Hurst, N. C.
Hutchinson, George
Hyde, Wm. Herbert

Ide, C. W.
Iglesder, Francis X.
Ingersoll, F. B.

Jacobson, S. L.
Jandt, Charles H.
Jeansen, Carl F.
Jenssen, L. N.
Jones Bros.
Jones, Edward
Jones, H. Merideth
Jones, Jos. L.
June, Robert F.

Kahler, C. P.
Kahn, Julius
Kaufman, Gustave
Kelly, Earl W.
Kelley, Joseph G.
Kelly, J. W.
Kemper, Walter Y.
Kern, Joseph F.
Kershaw, C. G.
Ketchum, Milo S.
Kettewell, H. I.
Keyser, F. W.
Kilpatrick, W. G. H.
Kim, Jos. F.
Kinhead, D. R.
Kinsley, C. R.
Kinsley, T. P.
Klarc, Henry W.
Klein, Otto H.
Kling, S. J.
Klingsberg, W.
Knight, Frank B.
Knowles, J. H.
Knowlton, W. T.
Knuttschmidt, T. H.
Koenig, Arnold C.
Koerner, Carl Albin
Kotz, Harry A.
Kreshaw, C. G.
Kreuger, J.
Kuntz, S. T.
Kyle, Mathew L
Kyle, R. B.

Lacy, Orlando J.
Laing, G. W.
Landor, Edward J.
Lane, F.
Lane, G. S.
Lane, J. Harold
Langthorn, J. S
Laurin, James
Leicester, A. R.
Leonard, C. M.
Leston, T. H.
Levy, Harold A.
Lewis, F. T.
Lewis, Myron H.
Lilly, A. J.
Lilly, J. A.
Loewring, Reinhold
Look, M. J.
Loomis, T. H.
Love, A. C.
Lowe, P. L.
Loxterman, Howard B.
McAllister, Charles H.
McAllister, P. T.
McCarthy, C. H.
McCarthy, Stearnes & Co.
McClintock, H. E.
McCurdy, J. F.
McDonald, A. W.
McGrath, M. P.
McGrew, J. A.
McGronan, Charles J.
McGuire, F. J.
McKee, R. P.
McKiernan, S. G.
McMaster, A. T. C.
McMurty, Guy
McNeal, L. S.
McNeish, J. S.
Macdonald, F. A
MacDonald, Peter J
Macdonald, W. A.
Mack, W. W.
MacGregor, J. T.
Mackall, R. C.
Maney, J. J.
Manly, Frank
Manley, Fred J.
Markee, John E.
Marony, John A.
Marston, W. S.
Martin, Charles C.
Marsh, M. M.
Marcellus, J. B.
Martin, H. B.
Martin, F. O.
Mees, C. A.
Merritt, Fruman H.
Metcalf, D. B.
Metropolitan Contracting Co.
Meyer, Rudolf
Middleton, P. K.
Miller, S. D.
Mills, Frank N.
Minto, Wm.
Mitchell, E. G.
Monaghan, Edw. J.
Monahan, John J.
Montandon, H. L.
Monteith, Arthur D.
Mook, M. B.
Mooney, B. & Sons
Mooney, J. F.
Moore, A. R.
Moore, De Witt V.
Moore, Wm. S.
Moorshead, T. C.
Moran, H. P.
Morrison, E. T.
Morrison, Henry C.
Morrison, Herbert H.
Morrow, H. A.
Morser, E. J
Moskowitz, J. A.
Mozart, William J.
Mullen, Luke D.
Mulville, John C.
Murphy, R. Lincoln
Murray, C. T.
Murray, Chas. W.

Nawn, H. P.
Nelsen, George
Newton, George C.
Newton, G. J.
Nichols, G. H.
Nicholson, George
Norcross, P. H.
Noyes, Arthur P.
Nusbickel, F. H.

Oakes, G. W. & Co.
O'Connor, James T.
Olmstead, Herbert
Ouellette, R. C.

Packard, I. Rupert
Paget, R. E.
Palmer, John C.
Palmer, L. G.
Palmer, Miguel C.
Park, James C.
Parker, A. F.
Parker, Jno. W.
Parker, O. K.
Parker, Thatcher A.
Parmlee, Charles L.
Parson, J. L
Patterson, Herbert S.
Patterson, Robt. Y.
Pearson, Frank C.
Peckinpaugh, C. L
Pellerin, Francis V.
Pendleton, George H.
Perkins, L. M.
Perrine, W. F.
Perry, Charles E.
Phillips, J. B.
Pierce, Charles H.
Pike, George B.
Pitt, E. D.
Pollak, Robert R.
Porter, H. P.
Postle & Waddingham
Powell, Norman S.
Predergast, F. E.
Priest, E. B.
Pulford, C. H.

Quignet, Chas. H.
Quilty, T. Frank
Quimby, C. H., Jr.
Quirk, E. McG.

Rabitt, P. S.
Ralston, Clarence E.
Raschbacher, H. G.
Rathjens, George
Rauschenberg, O. C.
Reasoner, R. B.
Reece, O. T.
Reed, Howard S.
Reed, W. C.
Reid, A. L.
Reid, Homer A.
Reid, J. G.
Renick, Seymour
Rhodes, William S.
Rhodin, C. J.
Rice, D. M.
Richmond, Frank J.
Ricker, R. F.
Riley, John D.
Ripley, C. M.
Roberts, C. W.
Roberts, Edward B.
Roberts, J. A.
Roberts, Vaughan M.
Robertson, Wm. E.
Robinson, E. J.
Robinson, Geo. Prentiss
Robinson, L. G.
Roddey, John H.
Rogers, C. H.
Rogers, J. S.
Rollins, H. L.
Rollins, N. A.
Rollins, Ralph H.
Rosborough, C. M.
Ross, E. S.
Rowe, Wilfred L.
Rowley, A. W.
Russel, R. L.
Russell, W. G.
Ryan, Richard R.
Ryan, Walter J.

Samuel, Geo. F.
Sample, William C.
Sanborn, John L.
Sanctuary, E. N.
Saner, C. C.
Sargent, Joseph A.
Saunders, Henry W.
Sayn, Albert L.
Scales, Geo. C.
Scammell, J. H.
Schilling, A. H.
Schoch, John A. S.
Schreiner, B.
Scott, G. E.
Scott, Morse P.
Scribner, H. D.
Seabury, George T.
Seaver, J. W.
Sebold, R. P.
See, Thos. H.
Seelig, Ed. F.
Semon, Edward G.
Serber, D. C.
Sharp, Thurlow R.
Shaw, H. L.
Shaw, Walter A.
Sherrill, Samuel S.
Shinholser, Steve O.
Simmons, W. H.
Singleton, Thos. D.
Slagel, Franklin G.
Slater, W. A.
Slifer, Hiram J.
Smaill, Wm.
Smith, F. A.
Smith, Godfrey L.
Smith, Lewis E.
Smith, P. H.
Smythe, F. A.
Smythe, Wm. R.
Snell, L. J.
Snow, Geo. W.
Snow & Sherrill
Snyder, Frederic A.
Snyder, Ralph M.
Solomon, G. R.
Solomon, Julian M., Jr.
Solomon-Norcross Co.
Soner, C. C.
Soper, Ellis
Sourby, John R.
Spuhler, H. A.
Staples, C. Bayard
Steele, Maurice E.
Steffens, Charles J.
Stephens, F. W.
Stephens, H. Morton
Sterber, D. C.
Stewart, J. M.
Stickle, H. S.
Stiger, Jno. S.
Stingel, Edward
Stone, Joseph H.
Stone, W. A.
Story, George
Strange, V. P.
Strassberger, L. W.
Street, Geo. G.
Surveyor, Arthur
Swan, G. C.
Swart, H. V.
Sweatt, Barton J.
Switzer, Vincent W.
Snydor, L. W.
Symmes, Whitman

Tank, John T.
Taylor, Andrew, Jr.
Taylor, E. A.
Taylor, Fred C.
Taylor, Lincoln
Taylor, W. C.
Thomas, Edw. C.
Thomas, Jacob
Thompson, A. D.
Thompson, Chas. M.
Thompson, Robert M.
Thompson, William L.
Thorneley, W. C.
Throop, A. T.
Tiffany, Nelson O., Jr.
Trainer, David
Travell, W. B.
Triebel, Albert
Turner, W. T.
Turney, Omar Asa

Uhl, W. F.
Ulmer, Joseph
United States Wind Engine & Pump Co.

Van Anken, A. M.
Vanarsdale, Deforest
Vance, W. N.
Vandruff, R. E.
Van Liew, J. E.
Veazey, V. S.
Vinton, M. E., Jr.
Vogt, Jno. H. L.

Wachter, Chas. L.
Wahlquist, Andrew
Walbridge, John T.
Waldo, W. B.
Waldron, Albert E.
Wallace, Louis R.
Waltman, W. D.
Ward, C. C.
Ward, Geo. Merritt
Warlow, A. Judson
Warner, Wm. H.
Warren, George
Warren, Wm. H.
Washburn, D. Cuyler
Weatherford, J. H.
Weaver, Frank M.
Webb, Henry
Webber, F. G.
Webster, Geo. H.
Weeks, W. C.
Weise, Fred E.
Wemlinger, J. R.
Werner, W. Alfred
West, R. L.
Western Construction Co.
Wetzler, Wm. H.
Weymouth, R. W.
Wheeler, E. T.
Wheelock, D. F. A.
Whipple, O. G.
Whitcomb, R. N.
White, Byron E.
Whitehouse, L. M.
Whittier, C. C.
Whorley, W. H.
Wiest, J.
Wilcox, Frank L.
Wilcox, Frederick
Wiley, H. L.
Wills, Arthur J.
Willis, M. H.
Wilson, Alfred B.
Wilson, Arthur R.
Wilson, H. Z.
Wilson, John
Wilson, John H.
Wiltsee, W. P.
Winchell, W. D.
Winston, J. O.
Wittmer, P. B.
Woerman, F. C.
Wolford, J. Dan
Wood, Chas. M.
Wright, James O.
Wright, Percy E.

Yanger, A. E.
Yerger, H. C.
Young, C. S.
Young, Henry A.
Young, W. W.

Zucco, Palmier

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

The Necessity of Continuity in the Steel Reinforcement of Concrete Structures.*

BY E. P. GOODRICH.

Concrete structures exhibit the usual phenomena of elastic solids, especially when they are provided with a skeleton of steel, properly proportioned and distributed throughout the concrete mass, according to circumstances. In the construction of concrete sidewalks and of most retaining walls, especially if of massive design, special effort is made to reduce within certain limits the size of the parts which will act as units. In some arches, efforts have been made looking toward a similar result, but in structures of that class, the present tendency seems to be to treat them frankly as continuous elastic structures, even though their detailed design is thereby rendered quite complicated. In such structures as lines of concrete pipe, separate units are being employed, even when of large diameters, but most work is of the continuous or monolithic variety.

No half way course is possible between these two classes of structures. If an arch is designed without joints but the reinforcement is not arranged for a continuous structure, joints are almost certain to form in accordance with Nature's laws by the cracking of the work, and sometimes they may occur at points which even threaten the stability of the structure. At least they are often exceedingly unsightly. A concrete sewer is out of sight and usually so arranged that there is a little danger of collapse should a few small cracks occur. But in this case another danger may exist. In a small city in a middle western state, a sewer was found to have become clogged so that it burst and flooded the cellars of adjoining property. Investigation showed that a root from a willow tree had entered the sewer through what must at first have been a very small crack, and had multiplied its fibers within the sewer to such an extent as to cause the trouble above mentioned.

The matter of building design will be more fully discussed a little later.

From even the two cases above cited, it would seem all important, when a concrete structure is to be constructed monolithic in character, so to distribute its reinforcement as to make it act like a continuous solid, and in its design treat it as an elastic structure subject to stresses and strains from its own weight, from the live load and its impact and variation in intensity, from changes of temperature, local settlement, etc. What follows will be almost entirely a discussion of the subject of continuity, as found in the structural member of buildings, it being taken for granted from this point onward that continuous structures should be erected with reinforcement designed to provide such static resistance as the continuous nature of the member demands.

A few concrete buildings have been erected in which the several structural members have been molded on the ground and erected and set in place in the same manner in which timber and steel work is handled. In the majority of cases, however, it has been the endeavor to secure a monolithic structure, and this theoretically monolithic nature has been one of the points much advertised as a great advantage inhering in concrete work. This very condition of perfect continuity has some minor disadvantages. Sound and vibration are transmitted much better in a less rigid structure, but the greater mass and the inherent nature of the propagating medium tend to absorb the vibrations so that at least one of these disadvantages is usually turned to a favorable property. A much more important point for consideration in this connection, is the fact that in structures composed of discrete members, innumerable joints naturally exist at which expansion and slight changes of position from deformation, can take place without endangering the structure, because brackets and other devices are provided to allow of such conditions. The first designers in reinforced concrete were so imbued with the ideas of the older types of structures that they thought of the several members of a concrete building as practically identical with those of all other types. The first regulations covering reinforced concrete work adopted by municipalities thus viewed this point, as is shown by their specifying that a factor of $\frac{1}{8}$ should be used in the design of beams, girders, and slabs. Very soon, however, trouble arose in buildings executed in accordance with such designs, which were being loaded to anything approaching their theoretically safe carrying capacity. Cracks occurred in the floor surface at the ends of beams and girders and slabs cracked away from beams in the same manner. These cracks were often ascribed to shrinkage or settlement or other factors, but in many cases were the necessary result of natural deformations of the structure. They showed that the same thing took place in concrete beams as happened in any other kind, but that allowance had not been made for such action. The next step was to require special reinforcement over points of support, to correct this trouble, and in order to secure some hypothesis for determining the amount to be used, advantage was taken of an observed fact that the factor $\frac{1}{8}$ could be reduced to 1/10 for various reasons for moments at the centers of beams. Since 1/40 measures the difference between this factor and the theoretical total, the amount of reinforcement thus determined was specified at the points in question.

When thus reinforced, a continuous beam possesses partial restraint at the ends. If a homogeneous beam of constant section be considered and one with a moment of inertia correspondingly less than a beam designed to carry the same total load when supported without restraint, it will be found that the theoretical slope of the neutral axis at the support is to be measured by the figure 7 as compared with 10 for a free beam. Such a slope would theoretically open a considerable crack at the top of almost any beam. Obviously if this condition existed, the steel designed to carry an amount of moment measured only by the factor 1/40 and at a stress equal to that of the steel near the bottom at the center, would actually be stretched much more than such a stress would deform it, and would consequently be carrying more than is above considered, with a correspondingly smaller slope of the beam. In a reinforced concrete girder, however, the moment of inertia is not constant throughout, and consequently the slope would probably be fully as great as first described above, even though the reinforcement was stressed beyond the permissible amount. If this actual stress happened to exceed the elastic limit of the top reinforcement, as may easily happen, a permanent deflexion would result in the top of the beam. Furthermore, a similar permanent set would have taken place in the concrete on the under side, below the crack, because of the high compression which would have taken place in the concrete. A repitition of the load would be likely to increase the first increment of deformation, and this increase would continue until a slope had been permanently secured, beyond which the added deflexions caused by the ordinary loading would not cause stresses above the elastic limit of either the steel or the concrete.

But in order to attain this state of affairs, the stress conditions in the beam may have far exceeded safe limits, and many observations have shown this to have actually happened in more than one building.

The dangers incident to such tension cracks adjacent to points of support are numerous. They occur where the shear in the beam is a maximum and unless ample reinforcement is introduced to resist these latter stresses (as is really very rarely done), their unit values will run up far beyond limits usually considered safe. These initial tension cracks also serve as starters for others which tend to occur from the diagonal principal tensile stresses. Cracks of the latter variety are apt to develop suddenly, producing destructive failure in test specimens, and there is no reason to suppose that more immunity would be found to inhere in actual structures, should the load ever reach a critical value. With the formation of such cracks, the zone of compression is obviously restricted to the uncracked part of the concrete, and if the crack is driven across the initial position of the neutral axis, the unit stresses in the extreme concrete layer must exceed permissible, safe ones. Then, too, in the cracked condition, the concrete can have no tensile value, and while this element is usually ignored in design work, its practical effect is well known to those who have made tests of beams and who have studied the subject of diagonal tension to any great extent. With a cracked condition, moreover, there is almost infinitely more opportunity for the reinforcing steel to be attacked by rust, with possible further incidental troubles. The few laboratory tests concerning this matter which have been made, principally in Germany, are inconclusive, and are best to be interpreted by the facts of actual experience, wherein rust has been discovered in connection with very fine cracks, when the metal was not covered with more than ¾ in. of concrete, as stated in a very late issue of a technical magazine.

---

*Paper read before the fourth annual convention of the National Association of Cement Users at Buffalo, N. Y.

The more steel is supplied over points of support (up to the theoretical necessary limit), the more are the above mentioned destructive tendencies reduced. Of course, with perfect restraint, twice as much reinforcement is required over supports as at the centers of beams. It is needless to state that this condition is almost never attainable at end bearings, although it is often closely approached at intermediate ones in large buildings, especially on the lower floors where heavy column loads give excellent stability to the members meeting at those points. With regard to the latter point, a column 16 in. sq. and stressed to 300 lb. per sq. in. for instance, will resist a moment of 28,800 sq. in. without developing tension on one side of the base if it acts only with its vertical load. This will be equivalent to that of a uniform live load of 832 sq. ft. distributed over a panel 20 ft. square. Of course such a column, if of any considerable length, would itself be bent to some extent by such a moment. This example tends to show the real action of the reinforcement usually installed and also indicates the necessity of a better form of splice on longitudinal rods in columns, than a piece of gas pipe slipped over the ends. On the upper floors, however, and in wall columns, special reinforcement must be installed if any real restraint is to be secured, above that afforded by the tensile strength of the concrete itself.

The same general reasoning applies to slender columns which may be flexed by beams supported by them as has been given for beams with deficient reverse moment reinforcement. This is particularly true with regard to the columns which have been designed to support long span, heavy roof girders. There is no reason why such a combination connot be analyzed, even as to the effect of unequal settlement, and the writer invariably makes an analysis of such designs, on the assumptions of rigid restraint at foundations, no shortening of the girder through its deflexion, and ignoring the bending effect on the column produced by the slight eccentricity of its load from the same cause. The problem then becomes one simply of a continuous beam over three spans with restrained ends, the parts having different moments of inertia. The solution is not particularly difficult, and by simple graphical methods the proper arrangement may be readily determined. It is usually found that more column steel is required than had been expected and that less end restraint of the main girders is secured than is often allowed.

Partial loads on continuous members over hinged supports gives maximum positive and negative moment curves different from those for full uniform load. In a monolithic structure no supports are as flexible as a hinge should be and consequently the full values thus obtained can be modified with perfect safety. A considerable study given to the subject seems to show that the amount of steel indicated by the use of 1/12 in computing the moment of a continuous uniform load, placed at both the top and the bottom of a continuous member is ample. Its proper distribution may be closely approximated by dividing the axis of a parabola into thirds and making the top and bottom steel overlap the amount shown by the center third. For various reasons, too, it is wise to run at least one rod from end to end of a continuous member along its bottom, in spite of the theoretical wastefulness involved. Some engineers also run one throughout along the top, and this is absolutely essential on short spans adjacent to longer ones. In such cases a careful analysis should always be made. Even in the floors of ordinary warehouses, deflexion experiments show considerable upward movement when alternate bays are loaded. Excessive loads, located in this way, might easily cause dangerous cracking in the unloaded bays, while the loaded ones were perfectly safe.

In a monolithic structure secondary stresses from local settlement, shrinkage during setting and changes of temperature are of much greater moment than in buildings constructed of discrete members with numerous joints. If local settlement takes place in a column, for instance, there is a tendency to produce worse cracking at points adjacent to the neighboring columns when the beams and girders are reinforced as simply supported ones than when they are treated as continuous. Much more elasticity is secured, a better distribution of stress and consequent diminished likelihood of annoying cracking. Furthermore, when cracking does occur, it is less likely to be of a dangerous character than when the members are reinforced as simply supported ones.

The shrinkage which takes place from setting is not usually sufficient to cause any trouble, except at such points as connections between floor slabs and the deep ribs of girders and beams, unless very large, long or deep stretches of work are placed in a single operation. Great care should be taken in the arrangement of the reinforcement at such points, the continuous type being altogether best even for floor slabs. In connection with such slab steel numerous stirrups should be provided to tie together the stern and the flanges of the T beam which is the actual statical condition of the member when under load. It may not be out of place to remark at this point that the actual effective width of flange in such T beams is probably not nearly as wide as is assumed by many engineers. Care should be exercised in the design of the reinforcement of heavy floor girders to see that enough reinforcement runs through the flanges of the T, across the top, to provide for the secondary bending stresses which are developed by the shearing stresses close to the stem. This condition is usually overlooked in connection with the members which run parallel with the floor slab reinforcement. Members running in the opposite direction secure ample assistance from the regular slab rods. Also that in continuous members, for ordinary loads, the neutral axis is so high in the vicinity of points of support that little is to be feared from possible compression failures at such points unless the compression stress condition within the zone is aggravated by the approach of a diagonal tension failure. The latter is the one shown indirectly as the cause of rupture in all the tests of continuous members with which the writer is acquainted, and to obviate which special care should be exercised in design work. That the computed compressive stresses run very high shows either that the confined condition adjacent to points of support makes such stresses possible, or that wrong methods have been used in their calculation or wrong assumptions made on which to base computations. All these are probably true. In designing the reinforcement for such continuous members care should therefore be exercised to provide as ample steel as possible, to assist the concrete in resisting compression, shearing and diagonal tensile stresses. Perhaps it is somewhat beside the point to state here that all tests of continuous members show great deficiency of the original concrete to withstand the developed diagonal tensile stresses without the addition of considerable steel in the form of stirrups or other heavier rods, either vertical or inclined, or both, and properly anchored at the ends. But the reinforcement for few buildings is designed with such an amount of reinforcement at those points and if continuous members are to be considered at all the present practice is open to considerable improvement As was said before, because structures remain standing is no criterion of their proper design and construction. The condition of numerous country highway bridges is a notorious example of the existence and continued use of sometimes actually dangerous structures.

Change of temperature is a potent cause of innumerable, unknowable, secondary stresses in many structures. In such buildings as tanks and long walls in which cracks are inadmissible, absolute continuity of reinforcement is essential. Nothing further need be said concerning such structures, except that it is not usually advisable to reinforce retaining walls so as to prevent cracking. Even where water tightness is necessary it seems wisest usually to undertake to secure it by the employment of a water tight expansion joint, together with water proofing by some method in connection with the portions of wall between joints. To be sure, in one instance of a reinforced concrete face for a high rock fill dam in the Sierra Nevada Mountains, a recommendation was made to carefully reinforce areas aggregating approximately 20,000 sq. ft., rather than to make use of water proof expansion joints under hydraulic heads over 100 ft. high.

In buildings of relatively small dimensions as to ground area, no expansion, or, rather, contraction, joints are necessary, especially in the upper stories. In long buildings some joints may be deemed advisable in order to obviate the heavy tensile secondary stresses which must sometimes exist and which show themselves by cracks, sometimes at unsightly and occasionally at dangerous points. In small buildings, the employment of numerous distributing rods through the floors at right angles to the regular carrying rods will usually be sufficient as far as the floors themselves are concerned. Around window and door openings special reinforcement should always be provided to prevent the formation of cracks which often start at all four corners and extend for short distances into the walls. Roofs are subject to extraordinary changes of temperature in their several parts, and need the greatest of care in the design of their reinforcement, especially when the slabs are treated as the flanges of long span roof girders.

In larger buildings clean cut joints may be installed and can best be placed at the centers of panels by providing cantilever beams as girders half a span in length on each side. Such joints should always be covered with an elastic water proof coating to shed the water falling on the floors in case of fire.

This discussion has been mainly on the subject of the prevention of cracks, a series of prescriptions for the overcoming of certain symptoms. While simple tension cracks on the bottoms of beams at their centers are not usually at all dangerous, since they commonly develop at comparatively low steel stresses, still the owner is not aware of this fact and is not readily convinced that there is no real defect when his building commences to crack. He wants a perfect structure and is entitled to receive it, particularly when possible danger of the formation of rust exists when cracks have formed, and more particularly when a slightly different arrangement of reinforcement would entirely eliminate the fancied or real trouble in question.

Logic thus seems to dictate that all structures which are at all monolithic in character, thus having members continuous over supports or through floor levels, should have their reinforcement so designed and placed as to make them act under all load conditions as their original monolithic nature would make them start to act.

Cost of Concrete Highway Bridges and Culverts in Greene County, Iowa.

The following figures of cost of constructing small concrete highway bridges supplement those published in our issue of Sept. 4, 1907. The work referred to was done in Greene county, Iowa, under the direction of Mr. Henry Haag, Jefferson, Ia., ex-chairman Board of Supervisors, and we are indebted to that gentleman for the information given. For the general methods of construction adopted in this work the reader is referred to the previous article; the character and cost of the two bridges referred to here were as follows:

Bridge I.—This bridge had a clear span of 8 ft. and was 5 ft. high. The floor slab was 22 ft. wide, 10 ft. long and 1 ft. thick and was reinforced with seven 7-in. T-beams 9 ft. long. The wheel guard was 16 x 12 ins. and was made of a 1—6 gravel concrete. A covering of 7 ins. of gravel and dirt was placed as a roadbed on the bridge which was opened to traffic three days after concreting. The falsework was kept under the bridge for 40 days. This bridge cost as follows:

Materials:	Total.	Per cu. yd.
40 cu. yds. gravel hauled 3½ miles at 75 cts....	$ 30.00	$0.91
40 bbls. cement at $2....	80.00	2.42
7 7-in. I beams 1,070 lbs. at 1 ct................	10.70	0.32
800 lbs. junk bars at 0.6 ct......	4.80	0.15
Lumber salvage and use.	15.00	0.45
Total materials	$140.50	$4.25
Labor:	Total.	Per cu. yd.
4 men excavating 2 days at $1.50..............	$ 12.00	$0.36
2 men erecting forms 1 day at $3 and $1.50...	4.50	0.14
4 men mixing concrete 4½ days at $1.50......	27.00	0.82
Hauling materials and tools	8.00	0.24
Filling, 2 men and team 1 day	4.50	0.14
2 men moving forms 1 day at $1.50...........	3.00	0.09
Total labor..	$59.00	$1.79
Extra Piling:		
28 10-in. stub piles at 50 cts.	$ 14.00	$0.42
3 men and team driving piles 2 days at $2.....	12.00	0.36
Total	$26.00	$0.78
Grand total	$225.50	$6.82

In figuring the unit cost of this bridge Mr. Haag deducts $28 as the cost of the pile work and gets $225.50 — 28 = $197.50 ÷ 33 = $6 per cubic yard.

Bridge II.—This bridge had a 16-ft. clear span and 20-ft. clear roadway between, 16 x12-in. wheel guards 32 ft. long. The bridge was 7 ft. high and the abutments had 8-ft. straight wing walls. Mr. Haag describes the remainder of the work as follows:

"In the floor slab I used four Kahn bars, 1 in. under spandrel walls and 23 ⅞-in. Kahn bars spaced 10 ins. In between these bars I used various kinds and sizes of rods, bars and angles selected from the junk pile. The angles were from a galvanized wind mill tower; these rods, bars and angles were crossed with 1-in. rods spaced 18 ins. apart; the concrete slab was 12 ins. thick. We dug the trenches for foundations 3 ft. deep below bed of stream, and secured a blue clay foundation, one of the best. On this we built the footings 2 ft. wide and 18 ins. high. The walls were 8½ ft. high, 14 ins. thick, reinforced with junk rods and bars 15 ins. on centers, extending up into floor 6 ins. This site is a dry run and we had no water during construction, but in a wet season and during a freshet it carries a large volume of water. We had a gravel pit right at the site, but the gravel would have to be washed and we had no water. We selected 8 cu. yds. of the best gravel for foundations, and the balance of gravel we hauled from the river, a distance of 4½ miles.

"We put 8 ins. of dirt and gravel on this bridge floor, had travel over bridge in five days after completion; false work supporting floor was left in for 45 days. The foundations were mixed 1—7, all the other gravel was mixed 1—6 river gravel, except in the hand rail we added one extra sack of cement to the yard.

"I constructed another bridge that contained 33 yds. of concrete and the bridge cost $211, or $6.40 per yard in place. My experience has been that in the small bridges, say 6 ft. to 12 ft. span, the average cost, under ordinary conditions, will be about $6.40 per yard. Larger spans will run around $7 per yard. This is where the work is done by hand. With a machine mixer I believe the cost would be reduced a small amount on the smaller jobs, and materially reduced on the larger bridges."

The itemized cost of the 53 cu. yds. of concrete in this bridge was as follows:

Materials:	Total	Per Cu. Yd.
8 cu. yds. pit gravel donated	$000.00	$0.000
50 cu. yds. river gravel at $1	50.00	0.943
65 bbls. cement at $2	130.00	.2.453
Kahn bars	50.00	0.943
2,400 lbs. junk iron at 0.6 ct.	14.40	0.271
Lumber, use of and waste charged	20.00	0.377
Total materials	$264.40	$4.987
Labor:		
Excavation, 3 teams and 3 men 3 days at $8	$ 24.00	$0.453
Building forms	10.00	0.188
4 men 6 days at $2 mixing concrete	48.00	0.905
Hauling lumber, cement, tools, etc	8.00	0.151
Man and team 6 days at $3 hauling materials to mixing board	18.00	0.339
2 men 1 day at $2 removing forms	4.00	0.075
2 teams 1 day at $3 filling in	6.00	0.114
Total labor	$121.00	$2.282
Grand total	$385.40	$7.27

Proposed Standard Tests for Concrete Building Blocks.

A set of specifications governing the method of testing hollow building blocks of concrete formed a part of the report of the special committee of the National Cement Users' Association on concrete blocks at the convention held Feb. 19-21. As showing the qualities which it is considered well made building blocks should have these specifications are reprinted here as follows:

(1) All tests required for approval shall be made in some laboratory of recognized standing, under the supervision of the engineer of the Bureau of Building Inspection, or the architect or engineer in charge, or all of these. The manufacturer may be present or represented during said tests if he so desires. Approval tests are made at the expense of the applicant.

(2) For the purpose of the tests, at least 12 samples or test pieces must be provided. Such samples must represent the ordinary commercial product and may be selected from stock by the Bureau of Building Inspection, or in the absence of such a bureau, by the architect or engineer in charge.

In cases where the material is made and used in special shapes of forms, too large for testing in the ordinary machines, smaller sized specimens shall be used as may be directed.

(3) In addition to the tests required for approval, the weight per cubic foot of the material must also be obtained and recorded.

(4) Tests shall be made in series of at least three, except that in the fire tests a series of two (four samples) are sufficient.

Transverse tests shall be made on full sized samples. Half samples may be used for the crushing, freezing and fire tests. The remaining samples are kept in reserve, in case duplicate or confirmatory tests be required. All samples must be marked for identification and comparison.

(5) The transverse test shall be made as follows: The samples shall be placed flatwise on two rounded knife edge bearings set parallel seven inches apart. A load is then applied on top, midway between the supports, and transmitted through a similar rounded knife edge, until the sample is ruptured. The modulus of rupture shall then be determined by multiplying the total breaking load in pounds by twenty one (three times the distance between supports in inches) and then dividing the result thus obtained by twice the product of the width in inches by the square of the depth in inches.

$$R=\frac{3\ W.\ l}{2\ b\ d^2}$$

No allowance should be made in figuring the modulus of rupture for the hollow spaces.

(6) The compression test shall be made as follows: Samples must be cut from blocks so as to contain a full web section. The sample must be carefully measured, then bedded flatwise in plaster of Paris to secure a uniform bearing in the testing machine, and crushed. The total breaking load is then divided by the area in compression in square inches. No deduction to be made for hollow spaces; the area will be considered as the product of the width by the length.

(7) The absorption test shall be made as follows: The sample is first thoroughly dried to a constant weight at not to exceed 212° F. The weight must be carefully recorded. It is then placed in a pan or tray of water, face downward, immersing it to a depth of at least two inches. It is again carefully weighed at the following periods: Thirty minutes, 4 hours, and 48 hours, respectively, from the time of immersion, being replaced in the water in each case as soon as the weight is taken. Its compressive strength while still wet, is then determined at the end of the 48 hours' period, in the manner specified in Section 6.

(8) The freezing test shall be made as follows: The sample is immersed, as described in section 7, for at least four hours, and then weighed. It is then placed in a freezing mixture or a refrigerator, or otherwise subjected to a temperature of less than 15° F. for at least twelve hours. It is then removed and placed in water, where it must remain for at least one hour, the temperature of which is at least 150° F. This operation is repeated ten times, after which the sample is again weighed, while still wet from the last thawing. Its crushing strength should then be determined as called for in section 6.

(9) The fire test is made as follows: Two samples are placed in a cold furnace in which the temperature is gradually raised to 1,700° F. The test piece must be subjected to this temperature for at least 30 minutes. One of the samples is then plunged in cold water (about 50° to 60° F.) and the results noted. The second sample is permitted to cool gradually in air, and the results noted.

(10) The following requirements must be met to secure an acceptance of the materials. The modulus of rupture for concrete blocks at 28 days old must average 150, and must not fall below 100 in any case. The ultimate compressive strength at 28 days must average 1,000 lbs. per sq. in. and must not fall below 700 in any case. The percentage of absorption (being the weight of water absorbed divided by the weight of the dry sample) must not average higher than 15 per cent and must not exceed 22 per cent in any case. The reduction of compressive strength must not be more than 33 1-3 per cent, except that when the lower figure is still above 1,000 lbs. per sq. in., the loss in strength may be neglected. The freezing and thawing process must not cause a loss in weight greater than 10 per cent, nor a loss in strength of more than 33⅓ per cent; except that when the lower figure is still above 1,000 lbs. per sq. in., the loss in strength may be neglected. The fire test must not cause the material to disintegrate.

The total production of pig iron in the United States in 1907 is estimated at 25,781,361 gross tons.

The total production of Portland cement during 1907 was approximately 48,000,000 barrels.

The 103,000 sq. yds. of creosote wood block paving laid in Minneapolis, Minn., during 1907 cost on the average $2.89 per square yard. Of this sum 58 cents was for the 5 in. concrete base and $1.79 for the treated blocks. The blocks used were mostly Norway pine, with some hemlock and tamarac. Portland cement cost $1.70 per barrel f. o. b. Minneapolis. Laborers were paid 25 cents per hour and teams 50 cents per hour. The city now has 330,000 sq. yds. of creosote wood pavement, the cost of which has ranged from $2.60 to $2.90 per square yard. There is one street of yellow pine which has been down for eight years and shows no signs of wear.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Comparison of the Cost of Wheel and Drag Scraper Excavation on a Job in Mississippi.

We are furnished the following data by Mr. M. E. Allen, civil engineer, of Shubuta, Miss., regarding the excavation of earth with scrapers.

The Kaupp Lumber Co., of Shubuta, Miss., wished to enlarge an old one-acre log pond, to give it an area of four acres. This required the excavation of the end bank and the extension of the side banks of the old pond, a distance of 350 ft.

It first seemed advisable to excavate the entire site of the proposed addition giving a depth of about 7 ft. throughout, which is the depth of the old pond. This plan would have necessitated the excavation of 7,220 cu. yds., only 1,725 of which would have been required on the dump. At a minimum cost of 20 cts. a cu. yd., it will be seen that such a pond would cost about $1,500.

As the site was full of pine, oak and gum stumps of considerable size, and extremely difficult to dislodge except with dynamite, it was decided to raise the old banks 1 ft., giving a depth of 8 ft. where the logs are unloaded and a minimum depth of 3 ft. 6 ins. in the far end of the pond over the 3-acre addition. In carrying out this plan it was decided that all stumps be sawed off at the ground, and that only enough dirt be excavated from the new pond site to build the banks, and that dirt be borrowed from the most advantageous places.

The cross sections showed that the banks would require 2,028 cu. yds. It was estimated that by doing the excavation by company's forces and teams the cost would not exceed $400.

There were on hand four ⅓ cu. yd. wheel scrapers and two slips. As there were 100 lin. ft. of bank so situated that dirt could be obtained right at hand and without plowing it was decided to let the slips handle the 162 cu. yds., and compare the costs for slips working under most favorable conditions and wheelers under average conditions. The two slips finished the 162 cu. yds. in 4.5 days, and, as the unit cost was found to exceed that of the wheelers under less favorable conditions, their use was discontinued.

The total cost of all the grading with slips and with wheelers was as follows:

Foreman 17.5 days at $3	$ 52.50
Labor 165.9 days at $1	165.90
Teams 145 days at $0.77	111.65
Total	$330.05

The cost per cu. yd. was 16.3 cts.

The cost under teams includes only the actual cost of feed used, for the teams were all company property. The drivers are listed under labor.

To arrive at a comparison for wheeler and slip work, 33 per cent of the foreman's time was charged to the latter during the first 4.5 days that the slips were used. This gave a cost for the slip work as follows:

1 foreman 4.5 days at (⅓ of $3) $1	$ 4.50
4 men 4.5 days at $1	18.00
2 teams 4.5 days at 0.77	6.93
Total	$29.43

Giving a cost per cu. yd. of 18.2 cts.

The cost per cu. yd. by items was:

Foreman	$0.028
Loading	0.028
Dumping	0.028
Slips	0.098
Total	$0.182

It will be seen that 18 cu. yds. were handled per slip per day. With two additional slips and teams and with one loader and dumper, the slips could have averaged 16 yds. per day. On such a basis 64 yds. would have been handled per day at the following cost:

Foreman	$1.00
Dumper	1.00
Loader	1.00
Slips	7.08
Total	$10.08

Making a cost per cu. yd. of 15.8 cts., which would have been slightly less than the wheel scraper work cost, offering a more favorable comparison with scraper costs given below:

WHEEL SCRAPER DATA.

Foreman 17.5 days at $3 (less $4.50)	$ 48.00
Labor 147.9 days at $1	147.90
Teams 136 days at $0.77	104.72
Total	$300.62
Cu. yds. handled	1,866
Cost per cu. yd	$0.161

The cost per cu. yd. by items was:

	Total.	Per cu. yd.
Foreman	$ 48.00	$0.026
Scrapers	160.22	0.086
Plowing	26.80	0.014
Snatching	30.60	0.017
Loading	17.50	0.009
Dumping	17.50	0.009
Total	$300.62	$0.161

To arrive at the dirt handled per scraper per day the following method was used:

4 scrapers were used 10.5 days	42
3 scrapers were used 7.0 days	21
Total scraper days	63
Total number of days	17.5
Average number of scrapers used per day	3.6
Total dirt handled	1,866 yds.
Average number cu. yds. handled per day	106.6
Average number yds. handled per scraper per day	29.6

It would be safe to assume that the average round trip haul was 400 ft., equaling a lead of about 150 ft., but it was absolutely impossible to collect any accurate data on that matter.

The low cost of this work may be largely attributed to (1) the low cost of labor, (2) dry weather, (3) plenty of company's mules on hand, so that by charging only actual feed consumed the ordinary teamster's profit was eliminated. On the other hand, frozen ground, many bogs, poor quality of labor and many roots and stumps tended to hinder the progress of the work and thereby increase the cost.

Cost of Shaft Sinking at Goldfield.

The following is abstracted from an article by Percy E. Barbour, mining engineer, of Goldfield, Nevada, in the "Engineering and Mining Journal."

The material excavated from a lineal foot of the 4x8 shaft was 1.84 cu. yds., making 184 cu. yds. of excavation for the 100 lin. ft. of shaft sunk by Mr. Barbour. In the table of cost we have added the column showing the cost per cubic yard of excavation:

"The shaft respecting which data are here given is located on the Daisy property in the Diamondfield district of Goldfield. It was started by a leaser and sunk to a depth of 102 ft., at a cost, as stated by him, of $80 per foot. The next 100 ft., sunk under my supervision, was accomplished in 31⅔ days of three 8-hour shifts each. The first 50 ft. were comparatively easy ground to work, 33 ft. being accomplished the first week. Then a new formation, a hard black andesite, was encountered, and 19 ft. was a good week's work. The last week only 16 ft. were made. It was necessary to increase the round from 7 to 14 holes, and even then, to accomplish results, the cut holes were fired and the muck hoisted before the other holes were shot.

"The shaft was 4x8 ft. in the clear, timbered with square shaft sets of 6x8-in. timbers, 5 ft. 6 in. centers. Dividers and posts were of 6x6 in. and guides of 4x4 in. material. The shaft was lagged throughout with 2-in. plank. Each set required the following timber:

Pieces.	Size, Inches.	Length. Feet.	Inches.
2 wall-plates	6x8	9	0
2 end-plates	6x8	5	0
1 divider	6x6	4	2
6 posts	6x6	5	1
27 lagging plank	2x12	5	6

Guides	4x4	11	0
Ladders	3x4	6	0
[illegible]	2x4	11	0

"This made a total of 539 ft. per set, plus waste in cutting, which was used for blocking, and was about 61 ft., making 600 ft. per set. In all 18 sets were required for the 100 ft. of shaft, so that 10,800 ft. of lumber and timber were required, say for computation 11,000 ft. The total cost of the shaft then figures as follows:

	Total Cost.	Cost Per Ft.	Cost Per Cu. Yd.
11 M feet timber @ $55	$ 605.00	$ 6.050	$ 3.29
50 wedges per set, say 1,000 in all @ 2½c	25.00	0.250	0.14
1,989 ft. "Bear" fuse, 1¼ case @ $10.50	13.13	0.131	0.07
356 lb. 40 per ct. dynamite @ 15c	53.40	0.534	0.29
403 caps—4 box, 4x, caps @ 80c	3.20	0.032	0.02
628 candles, 14 oz. 6's, 2.6 boxes @ $6	15.60	0.156	0.08
100 ft. 6 in. galvanized air pipe @ 30c.	30.00	0.300	0.16
Miners @ $5 and topmen @ $4.50	1,586.65	15.866	8.62
Hoisting engineers @ $5	475.00	4.750	2.58
One-half time of 1 man sharpening and framing @ $6	93.00	0.930	0.51
One-third time of foreman @ $7	72.50	0.725	0.40
Electric power 30 h. p. hoist @ $9 per h. p. per month	270.00	2.700	1.46
Oil, waste and grease (est.)	2.00	0.020	0.01
Total	$3,244.48	$32.445	$17.63

"The excessively high price of everything required—supplies, labor and power—will be noted. This is the reason that ore under $50 per ton cannot be profitably handled in Goldfield at present."

The cost per cubic yard for the first 102 ft. of the shaft as given by the leaser was $43.48, being about 2½ times as much as the work done by Mr. Barbour, whose work should have been more expensive than the leaser's, as the shaft was deeper and part of the material harder.

The average amount of dynamite used per cubic yard of excavation was 1.9 lbs. As Mr. Barbour states, the first 50 ft. of his work was in easy ground, while for the last 50 ft. 14 holes had to be used instead of seven. This gives an average, assuming the same charge was used in the holes continuously, of 1.3 lbs. of dynamite for the soft material and 2.6 lbs. per cubic yard for the harder material.

The Cost of Digging Some 600 Trolley Pole Holes.

Holes for trolley poles are generally dug by hand. Under most specifications they are not paid for by the hole, but are included in the price of other line work. For this reason few records of the cost of digging these holes have been kept. Poles used in large cities are generally of iron, and embedded in concrete, while those used in the smaller towns and on suburban roads are of timber. A different size hole is needed for each kind, so the cost of the holes varies somewhat.

In this article we will give the cost of digging more than 600 holes for trolley poles on a suburban line. The overhead construction was of two kinds, span wire which needs a pole on each side of the track, and single poles with a bracket to hold the trolley wire. This divided the work into two groups, and the span wire construction was further divided into double and single track work. The class of material in which the holes were dug, as well as the size of the butt of the pole, made additional division of the work. The cost of the work will be given under five groups.

A 10-hr. day was worked and the foreman was paid $3.00 per day and the laborers $1.50. The work was done during the months of February to July. The gang of men worked at digging the holes, raising the poles, and other overhead work during this period of time, but the cost of each item of work was kept separate. In digging the holes, the tools that the men used were: A digging bar, see Fig. 1; a round point shovel, see Fig. 2, and a spoon, see Fig. 3. The length of the handles on these were 8 ft. The holes were spaced as follows: For span construction on tangents, the poles were 110 ft. apart. On 12° curves or less they are from 80 to 110 ft. apart, while on curves of 150 ft. radius or less they were spaced from 40 to 50 ft. apart.

Tools Used for Digging Holes.

Group I. In this lot 82 holes were dug. It was for span construction of 4,775 ft. of double track. The poles were from 12 to 15 ins. in diameter at the butt, so the holes were dug about 2 ft. in diameter. The depth of the hole was governed by the specifications, which called for all holes to be 6 ft. deep, this depth to be in the natural ground. Hence where there was an embankment, the hole had to be as much deeper than 6 ft., as the height of the embankment was above the natural ground at the place where the pole was to be planted.

This is an instance of where conditions surrounding work may change, yet specifications are not changed to suit the new conditions. When these specifications were first drawn, all the poles on suburban lines of the company in question, were not placed equi-distant from the center line of the track. In cuts they were so spaced, but, wherever embankments occurred, longer poles were used, as the poles were placed outside of the toe of the slope of the embankment. This prevented having the poles in line, which made the line of poles appear unsightly, and it also added to the length of the span wire. For these and other reasons, the arrangement of poles was changed and they were set equidistant from the center line on the embankment as well as in the cut. Under these circumstances where the embankments had settled and were made of good material, there was no need of making the holes more than 6 ft., but as the specifications called for a greater depth, the holes were so dug. They varied from 6 to 12 ft. deep. In this group 40 pole holes were dug 6 ft. deep, the rest being from 9 to 12 ft., 30 holes being of the last named depth. The roadbed on this section was all embankment, made of cinders and slag from a steel plant. In digging the 30 deepest holes the cinders and slag kept running into the holes, causing about three to four times as much material to be excavated as would otherwise have been taken from the hole. It was estimated that this doubled the yardage excavated from the 82 holes.

In order to brace the poles under ground, an 8 ft. second-hand sawed tie was cut into two pieces, one 3 ft. long and the other 5 ft. long, and placed as shown in the cut. The short piece was put in the bottom of the hole and the large pieces at the top. This also increased the amount of material that was taken from the holes. This extra material averaged 4 cu. ft. for each hole, and the contractor was paid extra for this work. When holes were dug of a greater depth than the length of the shovel handle, a foot or more of earth was dug out of the surface of the ground at the side of the hole, and the workman stood in this depression, thus allowing him readily to reach with his shovel and spoon to the bottom of the hole.

The cost of digging the 82 holes was:

Foreman	$27.90
Laborers	95.25
Total	$123.15

The cost per hole was as follows:

Foreman	$ .34
Laborers	1.16
Total	$1.50

This high cost was due to the cinders as previously explained. The cost per cubic yard was:

Foreman	$ .13
Laborers	.47
Total	$ .60

The cost per lineal foot of double track for the hole digging was:

Foreman	$0.006

Men	0.020
Total	$0.020

Group II. All of these holes, 88 in number, were 6 ft. deep. The poles were a little heavier than those in Group I, so the holes were 2½ ft. in diameter. Each hole had 28 cu. ft. of earth in it, thus making 91 cu. yds. for all the holes. This was the first work done, and the men were not accustomed to handling their long handled shovels.

The cost of digging the holes was:

Foreman	$23.10
Laborers	83.10
Total	$106.10

This gave a cost per hole of the following:

Foreman	$0.27
Laborers	0.94
Total	$1.21

The cost per cubic yard was as follows:

Foreman	$0.25
Laborers	0.91
Total	$1.16

As there was 4,590 lin. ft. of double track, the cost of digging holes per lineal foot was:

Foreman	$0.005
Laborers	0.018
Total	$0.023

Group III. This was span wire construction for single track work, there being 17,160 lin. ft. of track. In all 320 pole holes were dug. The holes averaged 3½ ft. in diameter, and were from 6 ft. to 12 ft. deep. About 20 per cent were deeper than 6 ft., 10 per cent being 8 or 9 ft. deep, and 10 per cent from 10 to 12 ft. deep. From the holes 510 cu. yds. of earth were excavated, being 1.6 cu. yds. as an average from each hole. This large size hole was needed because the poles were extremely large in diameter and heavy—much larger than there were needed. This, too, was owing to the specifications, which stated the smallest size in diameter that would be accepted, but failed to state the largest dimensions that would be taken. Some of the poles furnished by the timber contractor were 3 ft. or more in diameter at the butt. This not only added to the cost of digging the holes, but also to the setting of the poles, and other details of the work. Special eye bolts had to be made for a large number of the poles, and some longer cross arms had to be obtained to carry the feed wires.

Ten of the 6 ft. holes were dug in quicksand. These gave some trouble, and additional expense. An expedient used in digging these holes was to take a barrel and after knocking the two heads out of it, to put it in the hole. Then all the excavation was done from within the barrel, sinking it as the hole was dug. Thus the sides of the hole were sheathed, and by means of a hand pump the water was kept out, while the digging was going on. If the quicksand occurs for a greater depth than the height of one barrel, a second barrel should be used on top of the first. This second one should be a little larger than the first, so it will go down around the lower one. The pole must be raised in such holes as soon as they are dug.

The total cost of digging the 320 holes was as follows:

Foreman	$77.80
Laborers	349.35
Total	$427.15

This gave the following cost per hole:

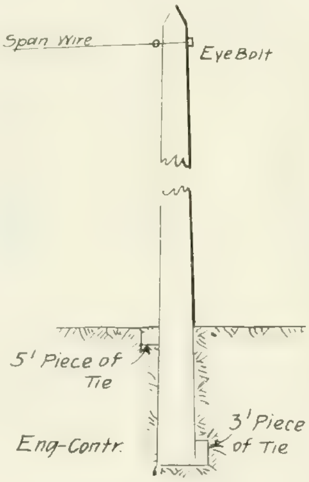
Foreman	$0.24
Laborers	1.09
Total	$1.33

The cost per cubic yard for the 510 cu. yds. was:

Foreman	$0.13
Laborers	0.68
Total	$0.81

The cost per lineal foot of single track for the hole digging was as follows:

Foreman	$0.005
Laborers	0.020
Total	$0.025



Sketch Showing Method of Bracing Poles.

Group IV. This was for 2,188 lin. ft. of single track, a branch of the other line. The curves were sharper, hence the poles on the curves were closer than on the main line. The poles were all less than 20 ins. in diameter, so the holes were made 2 ft. in diameter. There were 64 poles, and only a few of the holes were deeper than 6 ft. About 19 cu. ft. were excavated from each hole, no underground braces being used. This made 45 cu. yds. excavated from the 64 holes. The cost of digging the holes was:

Foreman	$ 9.00
Laborers	40.50
Total	$49.50

The cost per hole was as follows:

Foreman	$0.14
Laborers	0.65
Total	$0.79

The following was the cost per cubic yard:

Foreman	$0.20
Laborers	0.90
Total	$1.10

The cost per lineal foot of single track for the digging was as follows:

Foreman	$0.004
Laborers	0.018
Total	$0.022

Group V. This was side pole construction for single track, using a bracket made of pipe, on the pole. There were 5,700 lin. ft. of this construction, the poles being spaced about 80 ft. apart. Only a few of the holes were deeper than 6 ft., but as the poles were large ones the holes were 3½ ft. in diameter. The bracing blocks were used for these poles. An average of 36 cu. ft. was excavated from each hole, and, as there were 69 holes, 92 cu. yds. were excavated.

The cost of digging the holes was:

Foreman	$12.00
Laborers	54.00
Total	$66.00

This gives a cost per hole of:

Foreman	$0.18
Laborers	0.78
Total	$0.96

The cost per cubic yard was as follows:

Foreman	$0.13
Laborers	0.59
Total	$0.72

The cost per lin. ft. of single track was:

Foreman	$0.002
Laborers	0.010
Total	$0.012

A comparison of the cost of each group is shown in the following table, also the average cost for the entire **job**:

	Total cost	Cost per hole	Cost per cu. yd.	Double track. Cost per lin. ft.	Single track. Cost per lin. ft	No. poles.
Group I....	$123.15	$1.50	$0.60	$0.026	......	82
Group II..	106.10	1.21	1.16	0.023	......	88
Group III.	427.15	1.33	0.81	......	$0.025	320
Group IV..	49.50	0.79	1.10	......	0.022	64
Group V...	66.00	0.96	0.72	......	0.012	69
Average ..	.....	1.24	0.82	0.0245	0.0235*	

---

*Bracket construction (Group V) left out of this average.

It will be noticed that the cost per hole varied directly with the size of the hole. Adding to the diameter and the depth increased the cost. The cost per cubic yard was high when the hole was small and low when the hole was large. The cost per lineal foot for span wire construction varied but little. Naturally the single track was about the same as double track.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Tables for Estimating the Quantity of Materials and Cost of Gravel, Sand and Oil on Roads and Streets of Differents Widths.

We print herewith four tables that should be of use to engineers and contractors engaged in street and road work. We are indebted to the Petrolithic Pavement Co., of Los Angeles, for the tables, which were prepared by Mr. J. O. Marsh, C. E.:

COST OF GRAVEL IN CENTS PER SQ. FT. OF SURFACE AT VARIOUS PRICES PER CU. YD. AND SPREAD 1 IN. DEEP.

Cost of Gravel	$0.70	$0.80	$0.90	$1.00	$1.10	$1.20	$1.25	$1.35	$1.45	$1.50	$1.55	$1.60	$.165	$1.70	$1.75	$1.80	$1.85	$1.90	$2.00
Cost per sq. ft.	.216	.247	278	309	.340	370	.386	417	.448	.463	.478	.493	.508	.523	.538	.553	.568	.583	.598

COST OF OIL IN CENTS PER SQ. FT. OF SURFACE AT VARIOUS PRICES PER BBL AND QUANTITIES OF OIL PER SQ. YD

Gals. per Sq. Yd. of Surface. Per 42-gal. bbl.	$0.90	$0.95	$1.00	$1.05	$1.10	$1.15	$1.20	$1.25	$1.30	$1.35	$1.40	$1.45	$1.50	$1.55	$1.60	For each additional 5c per bbl. add
1	.238	.251	.265	.278	.291	.304	.317	.330	.344	.357	.370	.384	.397	.410	.422	.012
1½	.357	.377	.397	.417	.437	.457	.476	.496	.516	.536	.556	.575	.595	.615	.633	.020
2	.476	.503	.529	.556	.582	.608	.635	.662	.688	.714	.730	.767	.794	.820	.844	.026
2½	.595	.628	.662	.695	.728	.760	.793	.826	.860	.893	.926	.959	.992	1.025	1.055	.033
3	.714	.754	.794	.834	.873	.973	.953	.993	1.031	1.071	1.111	1.150	1.190	1.220	1.266	.039
3½	.834	.880	.926	.972	1.018	1.065	1.111	1.158	1.203	1.250	1.296	1.342	1.388	1.435	1.477	.046
4	.952	1.005	1.058	1.111	1.164	1.216	1.270	1.323	1.375	1.428	1.481	1.534	1.587	1.640	1.689	.053

LINEAR FEET OF STREET COVERED BY 1 CU. YD. OF GRAVEL SPREAD 1 IN. DEEP ON VARIOUS WIDTHS OF ROADBED.

Width of roadbed	20 ft.	22 ft.	24 ft.	26 ft.	28 ft.	30 ft.	32 ft.	34 ft.	36 ft.	38 ft.	40 ft.	42 ft.	44 ft.	46 ft.	48 ft.
Linear ft. of street	16.2	14.7	13.5	12.5	11.6	10.8	10.1	9.5	9.0	8.5	8.1	7.7	7.4	7.0	6.7

LINEAR FEET OF STREET COVERED BY 1 BBL. OF OIL (42 GALS). WITH VARIOUS WIDTHS OF ROADBED AND QUANTITIES OF OIL PER SQ. YD.

Gals. per sq. yd. of surface. Width of roadbed.	20 ft.	22 ft.	24 ft.	26 ft.	28 ft.	30 ft.	32 ft.	34 ft.	36 ft.	38 ft.	40 ft.	42 ft.	44 ft.	46 ft.	48 ft.
1	18.9	17.2	15.75	14.5	13.5	12.6	11.8	11.1	10.50	9.95	9.45	9.00	8.60	8.22	7.88
1½	12.6	11.5	10.5	9.70	9.00	8.40	7.88	7.42	7.00	6.64	6.30	6.00	5.73	5.48	5.25
2	9.45	8.60	7.88	7.27	6.75	6.30	5.91	5.56	5.25	4.97	4.72	4.50	4.30	4.11	3.94
2½	7.56	6.88	6.30	5.81	5.04	5.04	4.73	4.45	4.20	3.98	3.78	3.60	3.44	3.29	3.15
3	6.30	5.73	5.25	4.85	4.50	4.20	3.94	3.70	3.50	3.32	3.15	3.00	2.86	2.74	2.62
3½	5.40	4.91	4.50	4.15	3.86	3.60	3.38	3.18	3.00	2.84	2.70	2.57	2.45	2.35	2.25
4	4.72	4.30	3.94	3.64	3.37	3.15	2.95	2.78	2.62	2.49	2.36	2.25	2.15	2.05	1.97

Suggestions Wanted for Uniform Street Specifications and Highway Practice.

A committee of the Municipal Engineers of the city of New York is at work upon uniform specifications and highway practice for the different boroughs of New York City. The members of the committee are: George W. Tillson, chief engineer of highways, Borough of Manhattan, chairman; R. Walter Creuzbaur, consulting engineer of Public Works, Borough of Brooklyn; Samuel C. Thompson, principal assistant engineer of highways, Borough of the Bronx; Theodore S. Oxholm, principal assistant engineer of construction, Borough of Richmond; and Edwin H. Thomes, assistant engineer of highways, Borough of Queens, secretary of the committee.

The secretary has just sent out a list of about 100 questions relative to the proposed uniform highway practice in New York, from which we have selected a number of illustrative examples, as follows:

Specifications: General make up. Size, quality of paper. Size and style of type. Spacing. Width of lines. Margins. Position of page number. Cover. Color. Bound at side or end. General arrangement. Index, etc.?

Shall petitioners designate kind of curb, sidewalk, pavement, etc., desired, or shall the petition form call for curbing, sidewalks, etc., and the engineer determine their character, etc.?

What general conditions would determine the character and dimensions of the pavement and foundation to be used in each street?

What samples shall be submitted for each pavement and when? Any difference between requirements of new and of old bidders. Any affidavits of composition, manufacture, etc. Shall an excess in one requirement offset a slight deficiency in an other requirement, to an extent permitted by the engineer? What suggestions for a common central chemical and mechanical testing laboratory to secure uniform testing for all boroughs?

Any rule for fixing the security and number of working days, according to estimated cost, contract cost, the quantity and character of the items, etc., or other conditions? Consecutive working days or calendar days?

When shall day's working time begin and end? What deductions, etc., allowed and how made?

How shall measurements be taken and what shall be included and paid for in each item? Any deduction for spaces occupied by railroad tracks, base of columns, manhole heads, etc.? What pavement datum used?

Shall liquidate damages be $5 or $10 a day, or what?

How long maintenance period for each pavement?

Any maintenance for concrete curb or sidewalk?

Shall maintenance of all contracts expire at one stated time of the year, Dec. 1st or, two times, say June 1st and Dec. 1st, or May 1st and Nov. 1st?

What construction shall be used at railroad tracks, considering rails, ties, foundation, special paving along rails?

Shall price and maintenance of pavements at railroad tracks be specified in the contract?

Shall price for repairs be a fixed amount per unit, or the contractor's price, or some percentage of either, varying with the extent of opening, whether foundation is removed, or whether part of old materials are used again, whether due to street opening, fire, accident, malicious injury, wear and tear, whether at railroad tracks, etc.?

Shall a percentage or a fixed amount per yard, or as determined by the engineer, be retained for repairs and maintenance, or rely upon the bond alone, or a combination? How pay the retained portion, any interest, excess in one contract offset a dificiency in another?

What means shall be used to insure repairs, to satisfy claims, to indemnify the city, to hold sureties, etc., before the end of the guarantee period and bond?

At the end of the guarantee period, what minimum thickness and conditions of the pavement and blocks, will be accepted for each kind of pavement?

Prosecution of work, what extent of street opened? Responsibility for encumbrances, etc.?

What to specify for relaying and readjusting old curb, sidewalks, pavement, etc., sewer and water pipes, noiseless heads, house connections, etc., belonging to the city, to corporations, and to private owners? How designated, how paid for, etc. What information or plans given for proposals? Shall highway department relay any of the work?

Shall top soil be reserved for topping out sidewalks?

Rock excavation What sub grade? Any less in sidewalks? How classified? Size of boulders paid for as rock? Slopes? Stripping, tests, etc.?

Depth of layers of embankment? Proportion of stone allowed?

Shall road rolling be specified by total weight, by pounds per inch of width, by number of times rolled, by length of time, by puddling, or a combination of these, or all as required by the engineer? Shall city rent road roller to a contractor on optional terms fixed in the contract? Shall a rolling tamper of the Petrolithic type be used? Disk roller?

CURBING.

Bluestone, sandstone, granite? Any test for quality of stone?

Dimensions, order, minimum, maximum, and standard, length, depth, width any difference when set in concrete? What di-

Shall any tile, broken stone, cinder, gravel, or sand drainage bed, be laid under stone or concrete curb?

If so shall it be connected with sewer basins?

SIDEWALKS.

Flagstone, dimensions, minimum, maximum and standard length, width, depth.

How dressed? Shall certain allowable limits from a straight edge be prescribed in specifications for all dressing and laying of curb and sidewalks, or be left indefinite, or as required by the engineer? Proportions for mortar joint? What drainage bed? What specification for old flagstone relaid?

Cement Sidewalks: Materials. Dimensions, etc. Foundation? Concrete? Finishing surface? Size of stone? Proportions? Manipulation, etc.? Expansion joints, etc.? Shall street corners be filled in to both curbs? Shall street names be stamped in cement sidewalks or curb? Any extra thickness at driveways? How paid for, etc.? Shall surface be roughened when over .. per cent grade?

Gutters: Brick, granite block, etc.? Laid at right angles or parallel with curb? Bond with pavement? Foundation? Joints, etc.? Shall combined concrete curb and gutter be used? What materials, dimensions, etc.?

ASPHALT BLOCK PAVEMENT.

What specifications for materials Composition? Tests? Requirements, etc. Rock? Stone dust? Asphaltic cement? Flux Asphalt, natural, artificial, etc.? Degrees F. or C. Percentages by weight or volume? Size of blocks? Variations allowed? Pressure? Density and specific gravity. Absorption? Hardness, crushing, transverse, abrosion, and rattler tests, etc.?

Laying Asphalt Block: Mortar bed, proportions, how laid, wet or dry, templets, thickness, etc.? Shall the concrete foundation be brought to a perfectly smooth true surface when laid, and after it is set hard, shall the blocks be laid in a thin bituminous cement bed? If so, what specifications for the bituminous cement? Shall the joints then be filled with sand, or the paving cement, or wet grout, or dry sand and cement broomed in, what proportions, how manipulated, etc.? What lap, closures? What specifications for ramming or rolling, weight, size, material? What suggestions for design of a roller templet?

When shall coal or gas tar paving pitch be used?

PAVEMENTS.

Standard, minimum and maximum and special grades for each different pavement?

Same for crown and transverse section, any variation with increased grade, any special section along gutters?

Same for depth of gutters. Length and drop at driveways?

Street intersection corners, radius 9 ft. or what? Any difference for acute or obtuse angle, or for different widths of sidewalk and roadway, special cases, etc.?

What rules for grades at intersection, considering appearances, drainage, traffic, construction, breaks in grade, surrounding conditions, etc.? At right angle intersections shall all four corners be the same elevation or shall there be a difference on steep grades or along street car tracks or in special cases? What maximum grade between opposite corners? Shall maximum grade of curb and sidewalk from house line to curb line be fixed and break grade at house line for steeper grade? How determine grade at house line corner? At skews what rules for grades? What maximum difference in elevation of curbs at corners and at right angles across the street? Minimum and maximum grades and changes of grade by increasing or decreasing depth of gutters according to high or low point; or whether drainage is to be carried to a basin at the corner, or around the corner to the next block? Straight grades or break the grades opposite the acute angle, or where? What verticle curve, length, radius, etc.? By whom and how determined and what placed upon maps and plans?

Shall a book of standard plans, sections, symbols, rules, etc., be made up the same size as the contracts, or what?

Staking out and measuring up work. Size of stakes, distance apart, where placed, on lines or what offset, etc. What use of paint marks, colored crayons, lines, templets, etc., stationing, marks, etc.? What is given to the contractor?

What methods used in surveys and preparing plans, etc., for contracts? What shall be shown on plans relative to lines, grades, dimensions, names, surface and subsurface appurtenances, old and new work, etc., estimate, dates, etc.? Provisions for drainage, new basins, etc.? Test pits, borings, etc., sewer and water pipes, etc.?

What scales used for plans, profiles, cross sections, details, etc.? Horizontal and vertical, standard and special? Size of maps, etc.? How filed, etc.?

Standard conventional signs or symbols, abbreviations, etc.? What colors for different pavements, etc.? How is progress on contracts, etc., indicated?

What sized books, loose-leaf, etc., used for field notes, estimates, reports, etc.? What standard form of notes, etc.?

Card index? Filing system, etc., for letters, reports, contracts, estimates, complaints, note books plans, etc.?

Rules for assessment sheets, size, scale, arrangement, items, etc. How is Exc. and Emb. computed?

The committee will welcome any suggestions from city engineers. Address communications to E. H. Thomes, Queens Borough Hall, Long Island City, N. Y.

Object Lesson Roads Built in 1906-07 by U. S. Office of Public Roads, with Data on Their Cost.*

During the fiscal year ending June 30, 1907, the Office of Public Roads of the U. S. Department of Agriculture constructed 16 object-lesson roads. While this is a smaller number than were constructed during the previous year, the number of square yards of roads constructed during the past year far exceeds the number in previous years. Of the 16 object-lesson roads built in the past year, 11 were macadam, 2 earth, 1 stone surfaced with gravel, 1 gravel and 1 sand clay. The following tabulation shows the yardages of object-lesson roads constructed during the fiscal years 1905, 1906 and 1907.

	1905. Sq. yds.	1906. Sq. yds.	1907. Sq. yds.
Macadam	44,944	51,246	76,376
Gravel	8,804	4,197	11,722
Shell	5,877	933	0
Earth	0	12,132	27,042
Sand Clay	19,178	19,443	85,571
Burnt Clay	400	0	0
Totals	79,203	87,951	200,711

It will be noted from the above table that there was a large increase in the yardage of earth and sand clay roads. This is due to the efforts of the Office of Public Roads to introduce such forms of construction as are best suited to the means and requirements of the particular community.

A brief description of several of the object lesson roads constructed during the past year together with a table of data on their cost follow:

(1) Salem, Ore., Road.—Work was begun June 8, 1906, and finished Sept. 19, 1906, a total length of 5,340 ft. being graded, of which 2,480 ft. was an earth road. The remaining length, 2,860 ft., was macadamized, 1,360 ft. being surfaced with macadam to a width of 16 ft. and 1,500 ft. to a width of 12 ft. The subgrade was prepared with slight excava-

---

*From the report of Logan Waller Page, Director of the Office of Public Roads.

tion (100 cu. yds.) on an established roadway which had been graveled at intervals. Three courses of macadam were laid: 1st course, 8 ins. deep, of 2½-in. stone; 2nd course, 3 ins. deep, of 1½-in. stone; 2nd 1-in. top course of screenings and dust. The whole was compacted to 9 inches with a 10-ton steam roller.

(2) Oswego, Kans., Road.—Work was begun Aug. 25, 1906, and a total length of 4,600 ft. graded. Of this, 2,200 ft. was 26 ft. wide and 2,400 ft. 29 ft. wide. The width surfaced was 10 ft. and was placed on one side of the center of the graded portion to allow the roadway to be used as a combination earth and macadam road. The soil was a heavy gumbo, and was excavated with plows and drag scrapers, the material being spread and shaped with a grader. In this manner 2,000 cu. yds. of earth was handled, with an average haul of from 125 to 150 ft. The stone used for surfacing was a limestone quarried from ledges near the work. A total of 2,322 tons was placed upon the roadway, and was spread with automatic distributing carts and rakes. The surface consisted of a foundation course 6 ins. thick, a wearing course 3 ins. to 4 ins. thick before rolling, and a binder consisting of ½-in. to 1-in. screenings and dust.

DATA ON OBJECT-LESSON ROADS CONSTRUCTED IN 1906 1907

		Materials used.			Dimensions of Road.				Cost.			Cost of labor and teams per day.	
	Place.	Kind.	Cost per cu. yd. delivered.	Average haul, feet.	Length surfaced, feet.	Width surfaced, feet.	Depth compacted, inches.	Area surfaced, sq. yds.	Total cost.	Per square yard.	Rate per mile.	Men.	Teams.
1	Salem, Ore......	Macadam..	$0 78	1,400	1,360 1,500	16 12	9 9	4 418	$2,417	$0 547	$3,846 5,143	$1.80	$3 60
1	Salem, Ore	Earth			2,480				325		692	1 80	3 60
2	Oswego, Kan.....	Limestone		1,675	4 600	10	7	5,362	4,292	80	4,696		
3	Williamsburg, Va., No. 1..	Granitic gneiss, quartize and limestone...		4,614		20	6½	18,173	6,599	.363	2,556	1 00	
3	Williamsburg, Va., No 2	Sand-clay..				20		75,571	3,583	0308	595	1 00	
4	Benton, La......	Sand-clay..			5,120	35		19,864	1,779	089	1,835	1 25	3 50
5	Bozeman, Mont	Clay			2,640	14		3,520	749	16	749		
6	Dyersburg, Tenn::	Novaculite..	1 32		1,575	23	8	4,025	2,403	596	8,054	1 25	3 00
7	Lenoir City, Tenn.	Chert gravel.		3,000	1,900		9	7,178	1,694	235		1 25	3 00
8	Occoquan, Va.	Gravel		1,000	1,580	15-16	6 & 9	2,842		211	2,009	1 50	3 00
9	Pendleton, Ore	Basalt......		1,500	2,300	14	9	3,577	2,893	809	6,641	2 00	4 20
10	Anniston, Ala	Limestone...	1 12	3,960	2,660	14	6	4,141	2,890	698	5,732	1.25	3 50
11	Washington, D. C.	Trap, limestone.	*1 89		2,630	16	4	4,676	3,301	706	6,628	1 50	4 00

* Per ton.

(3) Williamsburg, Va., Roads 1 and 2. On Jan. 21, 1907, excavation was begun and work completed June 29, 1907. During this period but three whole days were lost on account of rain and bad weather. The greater part of the manual labor was done by convicts, their labor being credited at $1 per day. Free labor costs $1.25 and teams $3.50 per day of ten hours. Earth was loosened with plows and was moved with wheelbarrows, carts, drag scrapers, or wagons, according to the length of haul. The maximum haul was 1,200 ft., the average 365 ft. In this manner 9,050 cu. yds. of earth was excavated. A total length of 42,200 ft. of roadway was graded for a width of 20 ft., giving an area of 93,744 sq. yds. Of this area 18,173 sq. yds. was surfaced with macadam, and sand-clay construction was adopted for the remainder. The macadam surface was laid in three courses, as follows: A foundation course of granitic gneiss and quartzite 6½ ins. deep, uncompacted; next, a wearing course of from 1½ ins. to 2½ ins. of the same material; followed by a binder course of limestone screenings. The gneiss and quartzite were imported a distance of 80 miles by rail and were placed on the road with an average haul of 4,614 feet from the crusher. The limestone screenings were shipped 250 miles. In all, 4,714 cu. yds. of stone was used. The soil and subsoil over the remainder of the road was well adapted to sand-clay construction, as it ranged from a practically pure clay, with sand easily accessible, to a sandy loam. Intermediate portions represented all stages of sand-clay mixtures, and sand or clay was applied to each as became necessary to secure a durable mixture. In this manner 75,571 sq. yds. were treated. The quantities of earth and sand moved are included in the total number of cubic yards given in the description of Road No. 1. The cost of this work was $3,582.78, making a rate of 3.08 cents per square yard, or $595.09 per mile. The total cost of the work, Roads 1 and 2, was $10,181. Of this amount, $4,989.61 represents the cost of convict labor, estimated at $1 per day, leaving the cost of the work to the community $5,192. The country adjacent to the road was rolling, and drainage was quite simple. No tiling was required at any point, and the largest cross drain consisted of two lines of 24-in. pipe. The work was accomplished with one crushing plant of 80 cu. yds. capacity in ten hours, 1 road grader, 4 drag scrapers, 1 rooter and 2 road plows, a 12-ton roller and a sprinkler.

(4) Benton, La., Road.—Work was begun July 10, 1906, and on Aug. 11, 1906, 5,120 ft. of earth road, graded to a width ranging from 26 ft. to 43 ft., had been completed. Three-fourths of the road lay in a gumbo soil, while the remainder was a sandy clay. This was handled with plows, drag and wheeled scrapers, and was spread and shaped with a grader. There was 4,700 cu. yds. of excavation and 19,864 yds. of completed roadway.

(5) Bozeman, Mont., Road—Work was begun on an earth road on Sept. 17, 1906, and finished Oct. 8, 1906. During this time 2,640 ft. of road was graded to a width of 28 ft. of which a width of 14 ft. in the middle was treated with clay taken from a bank near the roadway. The soil was a dark alluvium containing a variable amount of clay, the mixture being too loamy to afford a good road surface. There was 1,208 cu. yds. of excavation handled, with an average haul of 170 ft., by means of wheeled and drag scrapers. The surfacing clay was spread with a road machine and compacted with a 6-ton horse roller. The cost includes a reinforced concrete culvert 18 ft. long, 4 ft. 6 ins. wide, and 2 ft. high in the clear, with appropriate end walls.

(6) Dyersburg, Tenn., Road.—Work was begun Aug. 22, 1906, and completed Nov. 1, 1906. Great delay was caused by the late arrival of the stone and by 16 days of rain. As a result, the clay subsoil was in a heavy condition. Macadam construction, 23 ft. wide, with 5½-ft. shoulders on each side, was adopted. Novaculite for surfacing was shipped from Tamms, Ill., at a cost of $1.32 per cubic yard delivered in Dyersburg. As this work consisted in improving a road already established, the cost of excavation was considerably increased because much of the old road surface had to be removed with picks and a rooter plow. Drag and wheeled scrapers were used in handling the excavated material and the roadway was shaped with a grader. A total length of 1,650 ft. was graded to a width of 34 ft., while 1,575 ft. was surfaced to depth of 8 ins. when compacted. The cost of this work, in excess of ordinary rural construction, was further increased by the necessity of lowering water and sewer pipes and properly refilling old trenches.

(7) Lenoir City, Tenn., Road.—Work

was begun Nov. 13, 1906, and completed May 3, 1907. Out of a total of 88 working days, 8 were lost because of delay in machinery and 56 from rain and inclement weather. As a consequence of the discouraging outlook it was decided to discontinue work until weather conditions should improve. After a break of a month, work was resumed on Mar. 18, 1907, and construction was pushed to a rapid conclusion. The material was a chert gravel from a pit about 3,000 ft. from the work. It was placed on the road unscreened, as it came from the quarry, all large particles being broken on the road by hand with a hammer. A 3½-ton horse roller was used and the gravel was rolled dry. A length of 2,000 ft. was graded, of which 1,900 ft. was surfaced. Of this, 800 ft. was 56 ft. wide and 1,100 ft. 18 ft. wide. The chert was placed in three layers: Two courses, each 5 ins. deep, and a surface course, 1½ ins. to 2 ins. deep, the whole being compacted to a depth of 9 ins. The total amount used was 2,400 cu. yds. A crown of nine-fourteenths inch per foot was adopted for both sections. There were 2,515 cu. yds. of excavation handled, with an average haul of 500 ft. The total cost of the work, exclusive of labor and material used on 88 ft. of 24-in. sewer pipe, was $1,694. In addition to the loss of time due to rain, the work suffered greatly from the demoralization of labor as a consequence of the many interruptions.

Mount Gilead, N. C., Road.—At this place a combination stone and gravel road was constructed according to the following method: The subgrade was shaped to receive a 5-in. layer of quartzite field stone, hammer broken to 3 ins. and less in size. This course was 12 ft. wide and was covered with a 6-in. layer of gravel 14 ft. wide, so placed that it merged into the earth shoulders. In this manner 1,450 ft. was paved with the quartzite and 1,080 ft. was completed by surfacing with gravel. The cost of the finished section was $151.35, giving a cost of 9 cts. per square yard. The total cost of the work was $205.75. The material used consisted of 230 cu. yds. of stone and 190 cu. yds. of gravel. Labor cost 80 cts. per day of ten hours and teams $2 per day. The stone and gravel were donated. No excavation was necessary, and the cost of the work was further reduced by the fact that the original road was well drained by ample side ditches. The gravel consisted of 65 per cent of quartzite and 35 per cent of clay, and was compacted by traffic, no roller being available. This work was done in five days, beginning Aug. 13, 1906, and the road was left to the community to complete.

(8) Occoquan, Va., Road.—Work was begun Aug. 21, 1906, and completed Sept. 15, 1906. Five days were lost on account of rain, and the cost of the work was increased by the heavy condition of the roadway at the time of excavation. A total length of 2,850 ft. was graded, of which 1,580 ft. was covered with gravel. This was so placed that it should be 9 ins. deep at the center and 6 ins. deep at the sides when compacted. The road was 15 ft. wide in one section and 16 ft. wide in the other. The gravel was donated from a pit within 300 ft. of one end of the work. Labor cost $1.50 and 2-horse teams $3 per day. The machinery used consisted of drag scrapers, breaking and rooter plows, a road machine, and a 3½-ton horse roller. The soil varied from a hard mixture of clay and gravel to a sandy gravel and a soft heavy clay. Two terra-cotta culverts were necessary, their face walls being made of rubble masonry. The total cost of the work was $601, and there remained 365 lin. ft. to be surfaced with gravel, which the community undertook to do without Government supervision.

(9) Pendleton, Ore., Road.—Work was begun Sept. 27, 1906, and completed Nov. 19, 1906. During this time a length of 2,300 ft. was surfaced to a width of 14 ft. and to a depth of 9 ins. compacted. The width graded was 25 feet. The soil over which the roadway was built was a light, loose volcanic ash, easily moved by the wind. There was slight excavation made, only 200 cu. yds. of earth having been moved over an average haul of 150 ft. The surfacing material was a heavy basalt, quarried from a ledge of rock an average distance of 1,500 ft. from the roadway, and was crushed to three sizes: 1-in. to 2½-ins.; ½-in. to 1-in. and 1-in. to dust. This was placed in three layers of 9 ins., 3 ins. and 1-in. respectively. A 14-ton roller was used in compacting the subgrade and the stone. One feature of the roadway worthy of special mention is that throughout the greater part of its length it is below the surface of the surrounding land. This is necessary to protect the roadway from the scouring action of the wind, which carries away the light, loose ash and leaves the stone unprotected. In this instance the roadway had been worn below the surface of the surrounding country, so that grading to secure this protection was unnecessary.

(10) Anniston, Ala., Road.—Actual construction was begun May 14, 1906, and completed Aug. 4, 1906. The soil ranged from a sandy clay to a chert-clay mixture and to a solid chert. As a consequence, excavation was difficult and picks were used in a large part of the work. There was approximately 6,600 cu. yds. of excavation handled in drag and wheeled scrapers and wagons over an average haul of 300 ft. The limestone already crushed for surfacing was shipped to Anniston by rail at a cost of $1.12 per cubic yard. The average haul from the railway siding to the roadway was three-fourths of a mile. The total amount of material used was 752 cu. yds., placed in the following manner: 1st course, 5 ins. deep, of stone ranging from 1½ ins. to 2½ ins. in size; 2nd course, 2 ins. deep, of stone from ¾ ins. to 1½ ins. in size, and a surface dressing of screenings and dust. The whole was compacted to a depth of 6 ins. by means of a 10-ton roller.

(11) Washington, D. C., Road—Work was begun on the driveway in the grounds of the Department of Agriculture on Aug. 16, 1906. There were 72 working days, 9 of which were lost because of rain and 10 because of nondelivery of stone. The total length of road surfaced was 2,630 ft. The width of surfaced road was 16 ft., and the depth of surfacing material 6 ins. before rolling. The amount of stone used was 1,240 tons, which was delivered on the work at a cost of $1.89 per ton. The first and second courses, 3½ ins. deep and 1¾ ins. deep, respectively, were of trap rock, and the binder course was of limestone screenings. This was compacted to 4 ins. with a 12-ton roller. The work consisted in grading and resurfacing an old gravel drive. About 400 cu. yds. of excavation was necessary to readjust grades, all of which had to be done with pick and shovel after loosening the earth with a spiked roller. Drainage was provided for by a series of drop inlets and catch basins connected with the city sewer system. Labor and teams cost $1.50 and $4 per day, respectively, and expert labor on catch basins $6 per day. On rural construction under similar conditions this rate per mile would have been considerably reduced by eliminating the elaborate drainage system, which consisted of one drop inlet and one catch basin with connections to each 525 ft. of roadway. The cost of construction was further increased by the irregular delivery of stone, resulting in much loss of labor.

Tropical and subtropical South America has 15,000 miles of railway.

The production of anthracite and coke pig iron for 1907 in the United States was 25,315,387 gross tons, exceeded the corresponding 1906 total by over half a million gross tons.

The total number of vessels arriving at New York from foreign ports during the year 1907 was 4,749, of which only 726 were American, while 2,039 were British and 710 German.

In the year 1906 the entire number of employes, including the apprentices and women, engaged in the service of the railroads of Germany, was 648,437.

According to accounts in the press, 932 automobile accidents occurred in Great Britain in 1907, killing 215 and injuring 675 people.

During the past three years the state railways of Chili have been provided with 140 new locomotives and 1,400 cars, and bids have been asked for 60 more locomotives and 700 additional cars.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

United States Reclamation Service General Specifications for Telephone Systems.

The United States Reclamation Service, of which F. H. Newell is director, is building a number of telephone lines in connection with the various irrigation projects being developed by it, and has found it advisable to draw up special specifications covering the construction of these lines. The following are the specifications as printed:

Pole Line.—The pole line will follow tangents and curves as shown in the drawings and will have the number of corners therein shown. An average of 30 poles per mile shall be used on tangents. The spans adjoining a pole on a curve at a corner shall not exceed 150 ft. each for a pull of 5 ft., and the allowable length of span shall decrease 10 ft. for each increase of 5 ft. in the pull up to and including a pull of 30 ft. When a bend made on a single pole produces a pull of more than 30 ft. the pole shall be thoroughly braced and guyed and the adjoining spans shall not exceed 100 ft. each, or such a bend shall be made on two poles and the lengths of the adjoining spans adjusted with the foregoing provisions relating to span and pull. The term "pull" as herein used means the perpendicular distance from the pole under consideration to a straight line joining the two adjacent poles. When a span of from 200 to 250 ft. is necessary, the adjoining spans shall not exceed 100 ft. each, and where a span of from 250 to 500 ft. is necessary, the adjoining two spans at each end shall not exceed 100 ft. each. On uneven ground the spans shall be so chosen and the poles so set as to avoid abrupt changes in the direction of the wire line vertically. In distributing poles, the heaviest shall be placed so far as practicable on corners and at the ends of long spans.

Poles.—Telephone poles shall be in general 5-in. poles 25 ft. in length. At crossings of highways, railroads and gullies 6-in. poles of requisite length shall be used, and for this purpose .... poles 30 ft. in length and .... poles 35 ft. in length will be required. The poles shall be cut from growing red or white cedar trees, shall be reasonably well proportioned for their length and shall be peeled, neatly trimmed, well seasoned, reasonably sound and free from unsightly wind twists, injurious butt rot and other defects that materially impair them for the use intended. Butt rot in the center, including small ring rot outside of the center, the total of which does not exceed 10 per cent of the area of the butt, will be permitted. Sweeps not exceeding 1 in. for every 5 ft. in length of pole will be permitted. The tops of seasoned 5-in. poles shall measures not less than 15 ins. in circumference and those of 6-in. poles not less than 18 ins. If the poles are measured when green 5-in. poles shall be not less than 16 ins. in circumference at the tops and 6-in. poles not less than 19½ ins. The top of each pole shall be trimmed so as to form a right-angled roof.

Painting.—The roofs of poles shall be painted with two coats of the best quality of iron oxid paint.

Setting Poles.—On tangents the poles shall be set in a vertical position, and on curves and at corners they shall be raked 10 ins. for a pull less than 5 ft., 15 ins. for a pull of from 5 to 10 ft. and 25 ins. for a pull of more than 10 ft. Each pole hole in earth shall be 5 ft. in depth and shall be dug of sufficient size throughout to admit of tamping around the entire perimeter of the pole. On hillsides the depth of the holes shall be measured from the lowest side of the opening. Where the line crosses solid rock, pole holes shall be blasted to a depth of 3 ft., unless such solid rock can be covered by a single span not exceeding 250 ft. Each pole shall be carefully held in proper position while the hole is being filled. Filling holes with earth shall be done by one man and the earth firmly tamped simultaneously by three men. Rock debris when used for filling holes shall contain sufficient earth to fill all cavities therein and shall be homogeneously placed and thoroughly compacted. When the hole is filled, earth or rock shall be piled and firmly packed about the hole to a height of 1 ft. above the original ground surface. The filling for holes and the general manner of setting poles shall be such as will enable each pole to withstand the strains to which it will be subjected.

Braces.—Braces shall be 5 ins. in diameter at the top, shall be long enough to attach to the pole at two-thirds the height thereof above the ground, to make an angle of 30° therewith and to extend into the ground at least 4 ft. measured along the brace and shall conform in all other respects to the specifications for poles ...... braces ...... feet in length, ... braces ...... feet in length and ...... braces ...... feet in length will be required.

Setting Braces.—Each brace shall be set in the ground at least 3½ ft. in vertical depth. The brace shall be cut slanting at the top to fit close to the pole and shall be attached to the pole with a ⅝-in. bolt supplied with a washer at each end. This bolt shall be placed at the lowest point of the joint. In fitting the brace to the pole all trimming shall be done on the brace.

Guys and Anchors.—Guys shall consist of No. 6, B. W. G., galvanized steel wire. Guy anchors in earth shall consist of galvanized cast iron plates and galvanized iron rods. Each cast iron plate shall be 8 ins. square and ½ in. thick and shall be provided on the lower face with a cylindical lug at the center having a diameter of 2 ins. and a height of 1½ ins. and with diagonal ribs ½ in. thick rising from zero elevation at the corners and terminiating in the cylindrical lug with elevation equal thereto. Each cast iron plate shall have a ¾-in. cored hole through its center for the reception of the anchor rod. Each galvanized iron rod shall be ⅝ in. in diameter and 6 ft. in length and shall be provided at the upper end with a suitable eye and a wire rope thimble for a ¼-in. rope and at the lower end with U. S. standard threads and a galvanized iron nut. Guy anchors in rock shall consist of galvanized iron rods of the combination eye and wedge-bolt type 1 in. in diameter and 18 ins. in length, each provided with a suitable wedge and a wire rope thimble for a ¼-in. rope.

Placing Guys and Anchors.—Each guy shall be attached to the pole immediately below the bracket by making two turns around the pole and wrapping the end eight times around the guy and shall be secured to its rod by passing around the thimble and terminating on itself in eight turns. The turns about the pole shall be secured by at least three 2-in. galvanized iron staples. The angle between the guy and its pole shall be as nearly 45° as is practicable. Anchors in rock shall be securely fastened in holes so drilled therein as to give the anchors the greatest possible efficiency. Holes for anchor plates shall be dug at least 3½ ft. in vertical depth.

Guying and Bracing.—Guys and braces shall be placed wherever considered essential by the engineer. On tangents and on curves having pulls less than 10 ft. double side guys will be required about every 1,000 ft. of line; and on curves or at corners where the pull is from 10 to 30 ft. each pole shall be provided with a guy or brace. On curves and at corners each pole at which the pull exceeds 30 ft. shall be provided with either a guy or a brace placed in the plane of each of the adjoining spans and the adjacent poles shall be provided with appropriate supplemental bracing or guying. At least one head and one back guy shall be installed on every mile of line. Additional head and back guys or braces shall be used wherever the slope of the ground, length of span, change in direction or extra pole height at road crossings requires them for stability.

Brackets (ground circuit.)—Pony telephone side brackets 1½ x 2 x 10 ins. shall be used. They shall be made of the best quality of well-seasoned, sound, straight-grained oak, free from knots and sapwood, shall have the insulator threads truly cut and complete and shall be painted with two coats of the best quality of iron oxide paint.

Each bracket shall be securely fastened to the pole with one 40d and one 60d galvanized wire nail in such a position that the base of the bracket will be about 14 ins. below the top of the pole. Where the change in direction of the wire at any pole is more than 60° an extra bracket shall be used. Brackets shall be placed on the same side of all poles except on curves or at corners, where they shall be so placed that the strains produced by the wires will tend to press the insulators toward the poles.

Brackets (metallic circuit.)—Pony telephone side brackets 1½ x 2 x 10 ins. shall be used. They shall be made of the best quality of well-seasoned, sound, straight-grained oak, free from knots and sapwood, shall have the insulator threads truly cut and complete and shall be painted with two coats of the best quality of iron oxid paint. Each bracket shall be securely fastened to the pole with one 40d and one 60d galvanized wire nail. Where the change in direction of the wire at any pole is more than 60° an extra bracket shall be used for each wire. On tangents the brackets shall be placed one on each side of the pole and on curves and corners they shall be so placed that the strains produced by the wires will tend to press the insulators toward the poles. The top bracket shall be so placed that its base will be about 14 ins. below the top of the pole, and the bottom bracket so that its base will be 12 ins. below that of the top bracket, except on transposition poles on tangents. On transposition poles on tangents the brackets shall be at the same elevation so placed that the insulator for each wire will be as nearly as practicable on a straight line between those for the same wire on the adjacent poles. On transposition poles on curves the bracket shall be so placed that the transposition insulator will be as nearly as practicable on a straight line between the insulators for each wire on the adjacent poles.

Insulators (ground circuit.)—Standard pony, glass, 10-ounce insulators shall be used. They shall be made of common glass, shall be free from cracks, blow-holes, flaws and sharp edges and shall have smooth threads of uniform pitch accurately fitting the threads on the brackets.

Insulators (metallic circuit.)—Standard pony, glass, 10-ounce insulators and two-piece transposition insulators of equivalent strength shall be used. They shall be made of common glass, shall be free from cracks, blow-holes, flaws and sharp edges and shall have smooth threads of uniform pitch accurately fitting the threads on the brackets.

Line Wire.—The line wire shall consist of No. 12, B. W. G., galvanized iron wire of the quality known as "Best Best," having an average resistance at 68° F. not to exceed 33½ ohms per mile. The wire shall be of uniform cross section, shall weigh approximately 165 lbs. per mile, shall have an ultimate tensile strength of not less than 545 lbs. and shall be capable of withstanding at least 15 twists about its axis in a length of 6 ins. It shall be soft and pliable and capable of elongating 15 per cent without breaking, after being galvanized. The diameter of the line wire in inches shall be not more than 0.113 nor less than 0.106. The wire shall be furnished in coils of one-half mile continuous lengths, without welds, joints or splices, and each coil shall be drawn from a rod without welds, joints or splices of any kind. The galvanizing shall consist of a coating of zinc evenly and uniformly applied in such a manner that it will adhere firmly to the surface of the iron. The galvanizing shall be of such quality that clean dry samples of the galvanized wire shall appear black when they are four times alternately immersed for one minute in a saturated copper sulphate solution and then immediately washed in water and thoroughly dried.

Stringing Wire.—The wire shall be strung with as few joints as possible and shall be joined by twisting the wires for a distance of about 3 ins. around each other two complete turns and soldering, the end of each wire terminating in five tightly fitting contiguous turns around the other wire. The line wire shall be tied to the insulators with tie wires of No. 12, B. W. G., galvanized iron wire cut in suitable lengths. The line wire shall first be laid in the groove of the insulator on the side away from the pole, after which the tie wire shall be passed entirely around the insulator and line wire and terminate at each end in five tightly fitting turns around the line wire. The tension on the line wire for each span shall be in the judgment of the engineer as high as will be safe for the minimum temperature for the locality.

Transposition (metallic circuit.)—In general a transposition of the line wires shall be made once in each mile, but the exact number and location of transpositions shall conform to the local requirements therefor. On tangents each transposition shall be made without the use of transposition insulators by interchanging the wires laterally in one span and vertically in the two succeeding spans. On curves each transposition shall be made by the use of a transposition insulator.

Trimming Trees.—All trees along the line of such character and location as to render them liable to being blown over so as to interfere with the telephone wires shall be cut down and removed or burned, and all trees close to the line that in the judgment of the engineer will not endanger the telephone wires shall be so trimmed as to leave a clear space of 10 ft. about telephone wires in all directions under stress of the heaviest probable wind storms.

Lightning Rods.—Lightning rods consisting of No. 12, B. W. G., galvanized iron wire shall be installed throughout the line at intervals of about one-third mile. Each rod shall be located about one-fourth the distance around the pole from the bracket and shall be attached to the pole with 2-in. galvanized iron staples. The upper end of each rod shall project about 3 ins. above the top of the pole and the lower end shall terminate beneath the butt of the pole in a flat coil containing about 6 ft. of wire.

Lightning Arresters.—A lightning arrester shall be installed on each line pole at which the current in transferred from the line wire to a station wire. The arrester shall be of the double-pole, lightning and sneak-current type, shall have adjustable and removable carbon blocks mounted upon porcelain bases and shall have fuses that will adequately protect it from lightning and sneak currents. The arrester shall be connected with No. 12, B. W. G., galvanized iron wire to any existing water pipe system near by or to a galvanized iron ground rod ½ in. in diameter and 6 ft. in length driven into permanently moist earth. The connecting wire shall be carefully soldered to the water pipe or to the ground rod. Twenty-five extra sets of fuses shall be furnished with each arrester.

Station Wiring (ground circuit).—The current shall be carried into buildings on No. 18, B. & S. G., rubber-insulated copper wire covered with black braid saturated with waterproof compound and carried on porcelain knobs having a diameter of not less than one and one-half inches. The return pole of each instrument shall be connected by means of a similar wire to any existing water pipe system nearby or to a galvanized iron ground rod ½ in. in diameter and 6 ft. in length driven into permanently moist earth. The connecting wire shall be carefully soldered to the water pipe or to the ground rod. Inside wiring shall consist of No. 18, B. & S. G., rubber-insulated copper wire covered with braid of a greenish color. All inside wiring shall conform to the best practice and shall be done only by expert electricians. Where wires pass through walls and partitions insulated bushing shall be provided.

Station Wiring (metallic circuit).—The current shall be carried into and out of buildings on No. 18, B. & S. G., rubber-insulated copper wire covered with black braid saturated with weather-proof compound and carried on porcelain knobs having a diameter of not less than 1½ ins. Inside wiring shall consist of No. 18, B. & S. G.,, rubber-insulated copper wire covered with braid of a greenish color. All inside wiring shall conform to the best practice and shall be done only by expert electricians. Where wires pass through walls and partitions insulated bushing shall be provided.

Instruments.—The telephones shall be of the long-distance bridging type, each comprising a granular carbon transmitter, a two-cell battery, a bi-polar hand receiver, a hook switch, a ringer of 2,000 ohms resistance and a magneto generator capable of easily operating at one time all of the ringers on the line.

The Economics of Snow Removal and a Suggested Improvement Over the Present Methods Used in New York.

BY RICHARD T. DANA

The problem of snow removal in New York does not appear to have been approached by the city authorities with an appreciation of the economics of the subject. Hence a brief discussion of the rules of transportation efficiency is here attempted to indicate what may be accomplished along these lines.

The writer's attention was attracted to the subject particularly when Major Woodbury adopted the plan of letting contracts for snow removal long in advance of a prospective snowfall by competitive bids on the yardage of snow to be removed, to be computed by the simple process of multiplying the areas of the streets to be cleared by the snowfall as given by the Weather Bureau. The contractor was to bid so much per yard and get busy when the snow stopped falling or thereabouts.

The method, with all respect to one of the best street commissioners that New York ever had or is likely to have, was unutterably bad, and for the following reasons:

(1) The snow fall in inches is a very poor criterion of the amount of snow to be removed from a particular point when the contractor reaches it, which was, I believe, frankly admitted after the system had been running a short time.

(2) The contractor had every incentive to wait for a partial thaw in order to get full pay for half the work, thus putting a first class premium on delay.

(3) In the case of a freeze the contractor was subject to a real hardship in the excessive cost of handling ice.

(4) The city had to have the right to require the contractor to get at designated streets at the order of a city sub-official, and by a little judicious selection of streets to be cleared in rotation a contractor could easily be helped or broken by a grafting official.

(5) An inspector would have almost unlimited power to graft by requiring a street as clear of ice in zero weather as a ball room floor. The writer saw some excellent examples of hand picked macadam last winter amid a desolation of sloppy surroundings.

(6) As a result of the uncertainty, a bid was a gamble with a tremendous margin of risk against the contractor in the event of adverse conditions and a tremendous profit with good luck.

The present method of doing the work is claimed to have great advantages over its predecessors in economy and speed, but it has had a rather brief and inconclusive trial so far this winter. The contractor is paid so much per cubic yard on the wagon. The method is essentially wrong economically for a number of reasons, among which are the following:

(1) From Trautwine's Pocketbook (1907 ed., p. 214) snow weighs from 5 to 50 lbs. per cubic foot, ice weighing 57.4 lbs. per cubic foot. To make a contract to handle snow by the cubic yard is about as fair and equitable and sensible a proposition as to handle toy balloons by the car load, without specifying the degree of inflation of the balloons or the size of the car.

A cubic yard of snow freshly fallen, and weighing about 270 lbs., may, after a day's adventures in a New York street, easily become so compact as to occupy one-third of its first volume, or so as to weigh 810 lbs. per cubic yard. Since it may take ten days or more to remove a single good fall of snow, no contractor can figure within a mile of what it should cost him to handle such material, and the data obtainable from experience on former work will be of almost no value in helping toward accurate estimates for the future. It is a maxim that to do any contract work economically it is necessary to be able to make reasonably accurate estimates on the part of the city as well as on the part of the contractor, and it is here contended that an equitable form of contract can be arrived at and reliable cost data can be obtained, involving very much greater efficiency in the snow removal, less cost to the city, less loss to the contractor and a much safer and surer profit.

These results can be obtained by the use of the methods to be outlined, and which would insure the placing of this work on a plane corresponding to that occupied by general contracting, where a reasonable profit compensates for a reasonable risk and where with adequate capital a contractor having skill and experience can have a fair run for his money.

The proposed plan is as follows:

(1) Let the city control, for use in snow removal only, a number of weighing platforms, each presided over by an inspector and a clerk, the inspector being provided with a registered "conductor's punch."

(2) Let the driver of each team be provided with a duplicate card similar to those in use on contract work employing teams, on which the inspector should punch opposite the number of each trip the gross and net weight and the time of weighing. The process of weighing, recording in the clerk's book and punching of the card will not occupy more than 25 seconds on an average.

(3) At the loading point an inspector with another registered punch should punch the leaving time of each load.

(4) At the end of the day the original of the punch card should go to the city's representative to be compared with the records of the weighing clerks, while the contractor should keep the duplicate, from which can be charted:

(a) The average time of loading.

(b) The average load.

(c) The average speed of hauling.

(d) The variations in performance of different teams.

(e) The cost from day to day of hauling in various streets.

(f) The efficiency of the various loading gangs.

(g) The variations in the cost of handling dependant upon the condition of the snow.

(h) The individual performance of each driver, on which bonuses can be given and by which competition among the men can be developed.

The benefits that can be counted on as certain of achievement from the proper use of the above data are as follows:

(a) A reduction of between 15 per cent and 25 per cent in the time and cost of loading.

(b) The placing on each wagon of its economic load.

(c) A reduction of from 15 per cent to 30 per cent or more in the time of hauling.

(d) A great improvement in the discipline of the drivers.

(e) An accumulation of data as to costs and time required to clear the various streets.

(f) A large reuction in cost of loading.

(g) A knowledge of the economic value of early attack on the freshly fallen snow.

The contractor should be paid for snow removal by the ton instead of by the yard. It is as easy to weigh a ton of snow as a ton of coal, and it is infinitely more accurate and just to do so than to guess at the cubic capacity of a wagon.

There would be so many checks upon individual performance that grafting by dishonest inspectors would be exceedingly difficult.

It will be to the contractor's advantage to get at the snow early before it had a chance to run away, and when the snow had been much compacted it would still be to his advantage to remove it quickly, since he would lose little or nothing by a shrinkage in volume.

If the contractor delayed and the sun melted the snow or half of it, the city would save that much money.

The establishment of the necessary weighing stations is a simple matter. One station could easily handle one loaded wagon and one empty wagon weighing in one minute and have much spare time. Thus 480 loaded wagons could be weighed per day of 8 hours. A 6-in. snow fall would weigh 5 lbs. per square foot, more or less, and each wagon should average two tons net, making 800 sq. ft. per load, or 384,000 sq. ft. of street cleaned per weighing station per day, or one station per two-thirds of a mile for streets 100 ft. wide, per day of 8 hours.

It is claimed that the method briefly outlined would result in a great saving of expense to the city, a profit to honest contractors and an immense improvement in the comfort, convenience and health of the people of the city of New York.

Consulting Engineer, 15 William St., New York City.

Methods and Costs; Some Old; Some New.

Blasting Ice.—In the early spring or during a prolonged thaw in the winter it is often necessary to remove large masses of ice which have collected at bridge piers or dams. These masses can often be broken by firing a charge of dynamite laid alongside of a favorable face, although it is sometimes necessary to drill holes in the ice. To break up a solid flat ice to make a passageway for vessels, holes should be chopped or bored through the ice at the desired points. Dynamite cartridges are then tied together and lowered with a string to the desired depth; the string is then attached to a stick laid across the hole. Four pounds of dynamite exploded 5 ft. below the surface will break ice 2 ft. thick to a distance of 30 to 40 ft. around the shot.

Preparing Road Subgrades.—In macadam road construction subgrades of slippery clay, showing increasing waves when rolled with a 12-ton to 15-ton roller have been consolidated, after subdraining with buried tiles, by covering the clay with a layer of freshly cut straw and then rolling with a 10-ton roller. Similar results have been gained by covering the clay with a single layer of ¼ in. to ½ in. green brush, rolled into the moist clay and then covered with an inch of gravel and again rolled. In the case of loose, fine sand the Massachusetts State Highway Commission has sometimes spread cotton cloth upon the sand and then covered the cloth with a light coating of crushed stone, rolling with a 10-ton roller and afterwards adding the necessary amount of stone to finish the road. The cotton cloth kept the sand from waving or pushing up in front of the roller.

Preventing Sediment from Being Drawn Into Condenser Intakes.—The New Claiborne Station of the New Orleans Railway & Light Co., of New Orleans, La., has four 72 in. pipes which serve the condenser intake and discharge. They extend through the levee, three being installed under the boiler room and the one placed under the railway tracks between the boiler room and the levee. The pipes are made in 30 ft. lengths of ½ in. riveted steel, protected by a coating 1-16 in. thick applied by dipping the sections into a hot compound. The provision made for removing sand and silt from the water pipes is comprised of water jets installed at 10 ft. intervals in the bottom of the pipes, and, by a system of valves the intake and discharge may be connected at the station end with an Allis-Chalmers motor-driven screw-pump, so located as to secure a flow of from 8 to 10 ft. per second through the pipes. When the cleaning is to be done, the jets are first operated to loosen the deposit, which is then worked out by the flow from the pump. The pump is driven by means of a 700 H. P. 550 volt induction motor directly coupled to it.

Cost of Drilling Test Holes.—This drilling was done with a Star drilling machine to test the site of a double track, steel trestle for concrete pedestal foundations. Seven holes were put down for a total depth of 190 ft. through clay and gravel to solid rock. The average depth of soil was 23 ft. and the average penetration into rock was 4 ft. The actual time consumed in drilling and moving from one hole to another was 11½ days and the total distance over which the drill was moved was 730 ft. The average time per foot of hole drilled, including moving, was 30 mins. The contractor furnished the drill and labor at cost plus ten per cent. on labor, and his bill was as follows:

	Rate.	Total.	Ft.
Driller, 11½ days.......	$3.50	$40.25	$0.212
Helper, 11½ days.......	1.75	20.13	.106
Teaming, 2.1 days......	4.00	8.40	.044
Labor, 10 days	1.75	17.50	.092
Use of drill, 11½ days..	2.00	23.00	.121
Coal, 45 bushels	.08	3.60	.018
4⅝ in. casing, 54⅔ ft...	.35	19.13	.100
Teaming, 1 day for other parties	...	4.00	.021
10% for Supt. and use of tools as above......	...	8.63	.046
Total		$144.64	$0.760

The above cost does not include any charge for inspection, as the regular inspector for the railroad company had to be on the ground to watch other work and could easily keep track of the drilling. For the above information we are indebted to H. M. Chapin, Resident Engineer, F. & C. R. R.

Transplanting Forest Trees.—The Forestry Service of the U. S. Department of Agriculture has recently issued a leaflet on the transplanting of forest trees and the matter in this note has been taken from that leaflet. The tree planter should endeavor always to transplant his trees with the least exposure to the roots. The root hairs, or feeding cells, on the roots of a plant will shrivel up and perish if exposed to the dry atmosphere for even a few minutes. The roots of conifers are particularly sensitive, so that these require more careful attention in transplanting than do broadleaf trees. Some of the broadleaf species may have their roots dried out and shriveled, yet with proper attention revive and live; but the conifers, once dried, rarely regain their vitality. The best time to transplant young trees is just before growth begins in the spring, when the seedlings are likely to receive the least injury. In general, planting should be done as soon as possible after the frost is out of the ground, the exact period depending upon local climate and soil conditions. In parts of the country where the winter is the only season with an abundant rainfall, the transplanting should be done during the rainy season. Fall transplanting in the prairie States is usually unsatisfactory, since the dry, freezing weather of winter often damages the young shoots. In the States east of the Mississippi fall planting is more successful, though small seedlings are often likely to be heaved out by the frost if not protected by mulching. Conifers, with the exception of the deciduous species, such as European larch and tamarack, may be safely planted somewhat later in the season than broadleaf trees. It is always well to choose a wet or cloudy day for transplanting, but if the work must be done in dry weather the nursery beds or trenches should be thoroughly soaked a few days before removing the trees. Seedlings grown for forest planting are usually transplanted, either to nursery rows or to the permanent site, when from one to three years old, and require no preliminary treatment. European foresters move young trees with balls of earth adhering to their roots, such trees being called "ball plants." Where the eucalyptus is cultivated on a large scale the seedlings are frequently prepared for easy transplanting by being grown in "flats" or seed boxes made of some durable wood. The plants may then be removed with a small block of earth attached to the roots. When the trees to be removed are large they are often prepared by digging them partly out in the fall, so that a large ball of earth may be frozen to their roots. The block of frozen soil, with the tree in it, is moved during the winter season to a hole which was dug before the ground became frozen. When a seedling or transplant is taken from the ground, its roots should immediately be plunged into a vessel containing a mixture of earth and water about as thick as cream. This mixture is known as puddle, and is one of the most important requisites for successful tree planting.

On Jan. 1, 1908, there were 69 steam shovels owned by the Isthmian Canal Commission erected and ready to work and classified as follows: Nine 45-ton, with buckets of a capacity ranging from 1½ to 1¾ cubic yards, 28, 70-ton, with buckets of from 2½ to 3 cubic yards, and 32, 95-ton, with buckets of 5 cubic yards. Of the entire 69 about 60 were at work at the beginning of the year.

The Isthmian Canal Commission is about to substitute fuel oil for coal in its various machine shops and power houses and, wherever practicable, under its stationary boilers throughout the Zone.

The total number of laborers imported from Europe for work on the Isthmian Canal during 1906 and 1907 was 9,914.

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review, timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are: First, to inform civil engineers and contractors of the articles and papers of merit, that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING-CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in.; 15 cts.

American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.

American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y.; m; 7x10 in.; 20 cts.

American Engineer and R. R. Journal (Am. Engr. & R. R. Jl.), York, N. Y.; m; 7x10 in.; 20 cts.

American Gas Light Journal (Am. G. L. Jl.), New York, N. Y.; w; 10x13 in.; 10 cts.

American Machinist (Am. Mchst.), New York; w; 7x10 in.; 15 cts.

Annales des Ponts et Chaussees (An. P. & C.), Paris, France; m.

Architects and Builders Journal (Arch. & Bldrs. Jl.), Baltimore, Md.; m; 9x12 in.; 20 cts.

Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.

Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.

Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.

Bulletin International Railway Congress (Bul. Int. Ry. Cong.), Brussels; m; 50 cts.

Bulletin U. S. Geological Survey (Bul. Geo. Surv.), Washington, D. C., 4x7 in.

Bulletin U. S. Department of Agriculture (Bul. Dept. Agr.), Washington, D. C.; 4x7 in.

Bulletins Railway Engineering & Maintenance of Way Association (Bul. Am. Ry. Eng. & M. of W. Assoc.).

California Journal of Technology (Cal. Jl. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.

Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x10 in.; 20 cts.

Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.

Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.

Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.

Canadian Mining Journal (Can. Min. Jl.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.

Canadian Municipal Journal (Can. Mun. Jl.), Montreal, Que.; m; 6¾x10 in.; 10 cts.

Carpentry and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.

Cassier's Magazine (Cas. Mag.), New York, N. Y.; m; 5x8 in.; 25 cts.

Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.

Cement Age (Cem. Age), New York, N. Y.; m: 4x7 in.; 10 cts.

Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.

Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.

Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.

Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.

Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.

Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.

Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.

Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.

Concrete and Constructional Engineering (Conc.. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.

Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.

Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.

Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.

Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.

Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.

Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.

Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.

Electric Railway Review (Elec. Ry. Rev.), Chicago, Ill.; w; 7x10 in.; 20 cts.

Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.

Electric Traction Weekly (Elec. Trac. Wkly.), Cleveland, O.; w; 7x10 in.; 10 cts.

Engineer (Engr. Lon.), London, England; w; 4x11 in.

Engineer, (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.

Engineering (Eng.), London, England; w; 8x11 in.

Engineering Digest (Eng. Dig.), New York, N. Y.; m; 5x8 in.; 20 cts.

Engineering-Contracting (Eng.-Contr.), Chicago, Ill.; w; 7x10 in.; 10 cts.

Engineering and Mining Journal (Eng. & Min. Jl.), New York, N. Y.; w; 7x10 in.; 15 cts.

Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.

Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.

Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.

Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.

Lé Genie Civil, Paris, France; w.

Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.

Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.

Industrial World (Ind. Wld.), Pittsburg, Pa.; w; 7x10 in.; 10 cts.

Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; $1.

Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.

Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.

Iron Trade Review (Iron T. Rev.). Cleveland, O.; w; 7x10 in.; 15 cts

Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.

Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.

Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.

Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.

Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.

Journal of Electricity, Power and Gas (Jl. Elec., P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.

Journal of Worcester Polytechnic Institute (Jl. W. P. I.). m; 4x7 in.; 20 cts.

Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.

Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.

Mines and Minerals (Mi. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.

Mining and Scientific Press. (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.

Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.

Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.

Modern Machinery (Mod. Mchy.), Chicago, Ill.; m; 7x10 in.; 10 cts.

Municipal Journal and Engineer (Mun. Jl. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.

Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.

Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.

Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w: 9x11 in.; 15 cts.

Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.

The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 ins., 15 cts.

Power, New York, N. Y.; m; 7x10 in.; 20 cts.

Proceedings American Institute of Electrical Engineers (Proc. Am. I. of E. E.), New York, N. Y.; m; 4x7 in.; 50 cts.

Proceedings American Society of Civil Engineers (Proc. Am. Soc. C. E.), New York, N. Y.; m; 4x7 in.; 75 cts.

Proceedings American Society of Mechanical Engineers (Proc. Am. Soc. M. E.), New York, N. Y.; m; 4x7 in.; 50 cts.

Proceedings Engineers' Club of Philadelphia (Proc. Engrs.' Club, Phila.), Philadelphia; qr.; 4x7 in.; 25 cts.

Proceedings Canadian Society of Civil Engineers (Proc. Can. Soc. C. E.), Montreal; m; 4x7 in.; 50 cts.

Railroad Gazette (R. R. Gaz.), New York; w; 8x11 in.; 15 cts.

Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.

Railway Age (Ry. Age), Chicago, Ill.; w; 7x10 in.; 10 cts.

Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.

Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.

Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.

Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.

Roadmaster and Foreman (Rd. & For.), Chicago; 7x-0 in.; 10 cts.

Rock Products (Rk. Prod.), Chicago, Ill.; bi-w.; 9x11 in.; 10 cts.

Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.

School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr.; 4x7 in.; 30 cts.

Schweizerische Bauzeitung, Zurich; w.

Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.

Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.

Sibley Journal of Engineering (Sib. Jl. Eng.), Ithaca, N. Y.: m; 4x7 in.; 20 cts.

Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.

Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.

Street Railway Journal (St. Ry. Jl.), New York, N. Y.; w; 7x10 in.; 10 cts.

Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.

The Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.

Waterproofing (W. P.), New York, N. Y.; m; 5x8 in.; 10 cts.

Zeitschrift d. Oest. Ing. u Arch. Ver. Vienna; w.

Zeitschrift d. Ver Deutscher Ing.; Berlin; w.

BOOK REVIEWS.

Proceedings, Association of Railway Superintendents of Bridges and Buildings. Published by the Society, Concord, N. H. Paper 6x9 ins.; pp. 314.

This latest volume of the Proceedings besides the committee reports, papers and discussions presented at the Milwaukee convention of 1907, contains a list of members and of the subjects of previous committee reports. The papers, committee reports and discussions cover the following subjects: Experience in Concrete Bridges, Arches and Subways, Concrete Building Construction Experience as to Expansion and Contraction on Concrete Walls, Action of Sea Water on Concrete, Wooden and Asbestos Smoke Jacks for Roundhouses, Combination Fastenings and Locks for Rolling and Sliding Doors, Construction of Towers and Guides for Lights on Drawbridges, Protection of Steel Bridges Against Action of Salt Brine from Refrigerator Cars.

Proceedings, Society for the Promotion of Engineering Education. Editors, Charles S. Howe, Arthur L. Williston and William T. Magruder. Office of Secretary, Pratt Institute, Brooklyn, N. Y. Cloth, 6x9 ins.; pp. 690; illustrated $4.

Besides the 50 papers read and discussed at the meeting held at Cleveland, O., in 1907, this volume contains a complete list of members, officers, standing committees, etc., and a copy of the constitution and by-laws. The large number and great variety of the papers and the long discussion which followed their reading preclude even a summary of their important features. Practically every phase of engineering education is touched on in the various papers and remarks and the whole forms a most useful and readable symposium on the subject of engineering educational methods in the United States.

Reinforced Concrete in Factory Construction. By Sanford E. Thompson. The Atlas Portland Cement Co., New York. Boards, 6½x9 ins.; illustrated.

The aim of this book is to interest owners in the possibilities and advantages of concrete for factory construction. To this end the first chapter presents a brief review of the qualities of reinforced concrete in comparison with other materials for factory buildings and is followed by a chapter giving the general principles of design and some information on methods of construction and then by a chapter on the selection of aggregates for concrete. These general chapters are followed by ten chapters each describing some one shop, factory or warehouse of reinforced concrete, selected with the view of preventing a variety of the more usual types of construction. A concluding chapter describes briefly and illustrates many of the styles or "systems" of reinforcement in common use in building construction. The chapters describing individual buildings will be found useful by concrete engineers as well as by owners. While the book is published primarily for trade purposes it is considerably more than a trade publication of even the better type and the publishers deserve credit for its publication.

How to Read Plans. By Charles G. Peker. Industrial Publication Co., New York. Cloth 5¼x7¼ ins.; pp. 46; illustrated; 50 cts.

The purpose of this little book is 'to give a simple explanation of the meaning of the various lines, marks, symbols and devices used on working drawings so that by its study the ordinary building mechanic can learn to read and understand the ordinary plans of his trade. Naturally the book is the A B C of its subject, but it is clearly and concisely written and should be useful to the class of workmen for which it is intended.

The Weathering of Coal. By S. W. Parr and N. D. Hamilton. University of Illinois Engineering Experiment Station, Urbana, Ill. Paper 6x9 ins.; pp. 36; illustrated.

This bulletin relates to the weathering of coal and losses in fuel values which accompany storage under various conditions. The information heretofore available concerning the behavior of coal in storage is exceedingly meager. The results of tests, as outlined in this bulletin, add materially to the information and open a way for a better understanding of matters pertaining to weathering, spontaneous combustion, and other difficulties which attend the storage of coal in large masses. Deterioration has been studied with samples maintained in the open air, under cover at varying temperatures, in air tight containers, and in the submerged conditions.

Comparative Tests of Carbon, Metallized Carbon and Tantalum Filament Lamps. By T. H. Amrine, University of Illinois Engineering Experiment Station, Urbana, Ill. Paper, 6x9 ins.

This bulletin gives a comparative study of the electrical characteristics, life, candle power maintenance, horizontal and vertical distribution and cost of operation of the three most widely used electric lamps under both good and poor conditions of operation. It is based upon a series of tests in which particular attention was paid to obtain exactly similar conditions for the three types of lamps in order to give a fair basis of comparison between types. Comparative rather than absolute results have been striven for though, in almost all cases, dependable quantitive values have been obtained. In an attempt to explain the reason for high efficiency of the newer lamps a study is made of curves plotted between "Filament Temperatures" and "Candle-power per square inch of Filament Area" and between "Watts per Candle-power" and "Filament Temperature." A consideration of these curves leads to the conclusion that the increase in efficiency of the metallized over that of the carbon filament is due almost equally to higher filament temperature and to selective radiation, while for the tantalum filament, it is due almost wholly to higher temperatures.

A Study of Roof Trusses. By N. Clifford Ricker. University of Illinois Engineering Experiment Station, Urbana, Ill. Paper, 6x9 ins.; pp. 28; illustrated.

About fifty trusses of a selected type and of different proportions and arrangement were designed in long leaf pine and steel and changed until the assumed and actual weights of the trusses agreed. Other trusses were likewise designed in white pine and steel and a few entirely constructed of steel. To perform this work as conveniently and as rapidly and accurately as possible, it became necessary to devise simplified formulas and tables, with a systematic method of treatment, all of which are fully explained in the pamphlet. The results illustrated are mostly shown in graphic tables for ready appreciation. The most important features are a new formula for the weights of trusses; per cent of weight to be added for connections; most economical ratio of depth to span of truss; distance between trusses; number of purlins per panel; and dimensions of panels. It was found that white pine and steel trusses are about 10 per cent lighter than those of long leaf pine and steel; also, that if carefully designed, steel trusses from 100 to 200 ft. span have about the same weight as those of white pine and steel.

BENSON'S
Payroll Manual
A handy volume compiled for use in preparing pay rolls. Wages due for any number of hours from 1 to 325, at usual rates from 5 to 50 cts. an hour, shown at a glance. Saves time. Avoids errors.
Price, $2.00 postpaid.
F. T. BENSON, Port Deposit, Md.

CONTRACTORS AND ENGINEERS
SAVE LABOR
Use Nash's Expeditious Measurer
A book containing 200 pages of tables which show at a glance the cubic contents of any stone or package according to its length, breadth and depth. Used by Contractors, Quarrymen and Engineers all over the world. Order of your bookseller or address the publisher. 1907 Edition Printed entirely from New Plates.
$2.00 Postpaid.
A. L. NASH
17 State Street :: NEW YORK
Send for Sample Pages
SAVE TIME

AVOID ERRORS
Get Our Prices
And Latest Catalogues
Before Buying Books On Any
Engineering or Contracting Subject
Write us To-day
The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

Tables of Five Place Squares and Logarithms of Feet, Inches and 32ds of Inches From Zero to 100 Feet
Logarithmic Secants for Hip, Valley and Rafters from Zero to 18 inches; rise of 1=foot base advancing to 32ds.
Logarithmic Functions, Natural Sines and Cosines for every minute of the quadrant.
By
G. D. INSKIP
The Only Book Giving These Values to 100 Feet
Engineers, draftsmen, ·ditors—all who have investigated the matter—say that this is the **best book of its kind that has ever been published.**
WRITE FOR SAMPLE PAGES
Flexible leather, tape bound, 5¼x7¼ inches; 280 pages; price $3.00 net, postpaid.
The Myron C. Clark Publishing Co.
355 Dearborn Street, CHICAGO

ROADS AND STREETS.

Detailed Costs of a Season's Work Laying Asphalt Pavements. By F. F. Puffer. Eng.-Contr., Feb. 5, 1905. 1 1-3 pp.

The costs cover 77,208 sq. yds. of paving, and are itemized in detail, labor and materials being recorded separately. In addition separate costs are given in detail of three different jobs to show how costs vary.

Municipal Asphalt Repair Plant at New Orleans: Its Cost and Data on Operation. Eng.-Contr., Feb. 5, 1908, 2 2-3 pp.

Describes the plant, and gives the cost of buildings, equipment, supplies and labor in detail, with general figures on output and pavement repair costs.

Experiments With Tar and Oil on the Highways of Rhode Island. Eng. Rec., Feb. 8, 1908, 2 pp.

A paper read before the American Association for the Advancement of Science,, by Prof. A. H. Blanchard, of Brown University. Gives records of various parts of roads treated with tar and oil, and some costs per square yard for treating. Also records showing results obtained from treatment. Likewise the analysis of oils and dust preventives used on roads. A paper of some value to road engineers.

Street Cleaning and Waste Disposal in New York. Eng. Rec., Feb. 22, 1908; 2 pp.

Being the synopsis of a report on this subject by a special commission, appointed by the mayor, consisting of H. DeB. Parsons, Rudolph Hering and S. Whinery. They recommend that flushing combined with hand sweeping will prove to be the best and cheapest method of properly cleaning the great majority of the streets of New York.

Gravel Roads in Michigan. By Frank F. Rogers. Gd. Rds. Mag., February, 1908; 2 pp.

Michigan has about 7,000 miles of road surfaced with gravel. The article treats of the gravels used on these roads, and discusses methods of construction.

A Year's Progress in Building Good Roads. Gd. Rds. Mag., February, 1908; 7½ pp.

This article contains a table showing the public road mileage and expenditures in the United States in 1904, and also includes brief reports from the highway commissioners of various states as to the work done during 1907, and the work which it is proposed to do in 1908.

The Commercial Use of Highways. By H. Howard Humphreys. Surveyor, Feb. 14. 1908; 5 pp.

A paper read before the Society of Road Traction Engineers, together with a discussion. The paper discusses the increased traffic on highways due to the use of the commercial motor and the resultant increase in the cost of road maintenance.

Municipal Lighting at St. Louis. By Charles Claude Casey. Mun. Jl. & Engr., Feb. 19, 1908; 3 pp.

The city of St. Louis, Mo., operates four small municipal lighting plants. This article gives considerable data on the operation of these plants.

Highway Construction in Massachusetts. By Charles W. Ross. Gd. Rds. Mag., February, 1908; 4 pp.

A paper read before the Massachusetts Highway Commissioners. Describes in a general way the methods employed by the State Highway Commission in the construction of macadam roads, and gives some hints as to special methods employed.

Dust Remedy for Macadam Roads. Gd. Rds. Mag., February, 1908; 1 p.

A specification prepared by State Highway Commissioner MacDonald for the application of coal tar as a preservative and dust layer on macadam roads.

Basis of Lighting Contracts. By Alton D. Adams. Mun. Jl. & Engr., Feb. 5, 1908; 1½ pp.

An article giving reasons why contracts for street lighting should provide for the delivery of definite volumes of gas or amounts of electric energy rather than for definite illumination.

SEWERS.

Diagram for Computing Run-off by McMath's Formula. By Samuel D. Bleich. Eng News, Feb. 27, 1908; 1-3 p.

Gives diagram and describes method of using it, with table showing degree of accuracy.

The Run-off of Several Areas. Eng. News Feb. 27, 1908; 1 p.

Preliminary report of the Committee on Run-off from Sewered Areas, Boston Society of Civil Engineers. Gives directions for obtaining run-off records and a useful bibliography of books and articles on run-off and sewer gaugings.

Investigations on the Purification of Boston Sewage in Septic Tanks and Trickling Filters. By C. E. A. Winslow and Earle B. Phelps. Tech. Qr., December, 1908; 65 pp.

A very comprehensive paper, followed by many references to reports and papers on sewerage purification. First is given the results of previous investigations and a study of the present sewerage discharge of Boston. Then is taken up analysis of samples of sewage discharge, showing method of sampling and resultant analysis, illustrated by diagrams. A description is given of the experimental plant. A table showing the composition of crude sewage is given. The results of septic treatment and trickling filtration are set forth and commented upon at some length. In the experiments both summer and winter weather was taken into consideration. The conclusions lead to the belief that the best method of treating Boston sewage, at the most economic cost, is by sedimentation and trickling filtration.

A Suspended Sewer. By W. R. Wortington. Can. Engr., Feb. 7, 1908; 2 pp.

The sewage from one of the suburbs of Toronto, Ont., is carried over a deep ravine, 600 ft. wide, through a steel pipe suspended from the floor beams of a bridge. The design of this pipe and the method of supporting it from the bridge are described in this article.

Sewerage at Ithaca, N. Y. Mun. Jl. & Engr,. Feb. 5, 1908; 3 pp.

A general descriptive illustrated article of the sewer system of this place. Sewage disposal is provided for by septic tanks and illustrations are given of these tanks.

GARBAGE AND CITY WASTES DISPOSAL.

Garbage Disposal at New Bedford. Mun. Jl. & Engr., Feb. 26, 1908; 2 pp.

Describes in a general way the garbage disposal plant of New Bedford, Mass.

Analyzing City Garbage. Mun. Jl. & Engr., Feb. 26, 1908; ½ p.

Gives method of obtaining average sample of garbage employed in the investigation of the garbage situation at Milwaukee, Wis.

Milwaukee Refuse Disposal Report. Mun. Jl. & Engr., Feb. 12, 1908; 1½ pp.

An abstract of the report of Rudolph Hering on the garbage disposal situation at Milwaukee, Wis. The article contains some data on the cost of garbage collection and incineration.

WATER-WORKS AND HYDRAULICS.

The Water-Works of Portland, Oregon. By W. P. Hardesty. Eng. News, Feb. 6, 1908; 3 1-3 pp.

A general account of the growth of the water-works of Portland, with descriptions of component parts, general figures of cost and some accounts of the workings of municipal ownership. A good general description article.

Logarithmic Diagram for Flow of Water in Open Channels. By Geo. T. Prince. Eng. News, Feb. 6, 1908; ½ p.

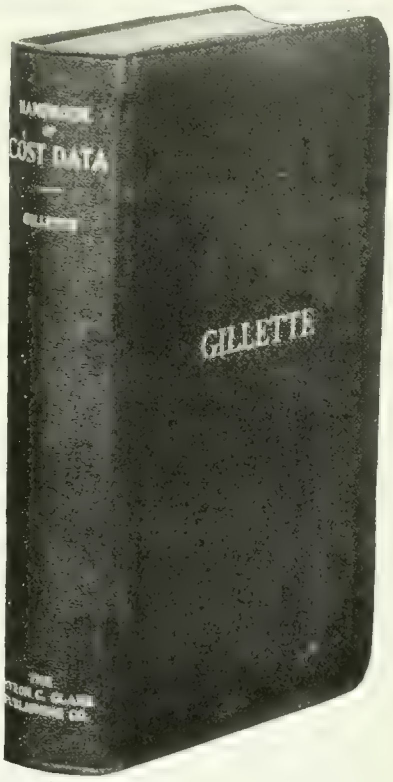
The diagram is based on the Chezy formula with value of C assumed as 100.

Water Level Gage. Eng. Contr., Feb. 12. 1908; 1-3 p.

Describes a device for measuring water level in deep wells.

Handbook of Cost Data
By HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting"

"Cost Data" has broken all records for the sale of technical books. Over 10,000 copies were sold in less than two years; 1,600 in last three months. The book has over 600 pages of actual costs taken from the private records of engineers and contractors, and so itemized and analyzed as to be of inestimable value to any person who has to do with making bids and estimates or in checking estimates. This covers the whole field of contract work, giving the cost of labor and materials required for every kind of construction from the laying of sod to the building of reinforced concrete sewers. No detail of contract work has been too small to be described and recorded. Wages and prices of material are given in every case, so that proper substitution can be made where conditions differ. It gives also valuable data on methods of construction, thus enabling foreman to handle work in the most economical manner possible.



The general headings are:

Cost-Keeping, Preparing Estimates, Organization of Forces, etc.
Cost of Earth Excavation.
Cost of Rock Excavation, Quarrying and Crushing.
Cost of Roads, Pavements and Walks.
Cost of Stone Masonry.
Cost of Concrete Construction, all kinds.
Cost of Water-Works.
Cost of Sewers, Vitrified Conduits and Tile Drains.
Cost of Piling, Trestling, Timberwork.
Cost of Erecting Buildings.
Cost of Steam and Electric Railways.
Cost of Bridge Erection and Painting.
Cost of Ry. and Topographic Surveys.
Cost of Miscellaneous Structures.

24 Page Circular, showing Contents and Sample Pages, will be mailed FREE on request.

THE MYRON CLARK PUBLISHING CO.
355 Dearborn St. Chicago

IRRIGATION AND DRAINAGE.

Construction of the Laguna Dam, Colorado River, Arizona. By Edwin D. Vincent. Eng. News, Feb. 27, 1908; 3½ pp.

The dam consists of three concrete walls 4,800 ft. long between bluffs and 57 and 93 ft. apart, filled between with rock and having rock fill toe and heel slopes; the rock fill between walls is covered with an 18-in. concrete paving. The article gives general drawings of this dam, describes its location, purpose and the general method of construction adopted. Costs were kept on the work and sample costs for two months are presented.

Electrically Operated Sluice Gates and Drop Timber Regulator Gates for the Laguna Dam. By F. W. Hanna. Eng. News, Feb. 27, 1908, 3 pp.

Gives general drawings of gates and operating machinery and describes main structural features and method of operation.

Swamp and Overflowed Land Drainage in the Mississippi Basin. By F. W. Hanna. Eng. News, Feb. 13, 1908; 1½ pp.

The author states that there are some 40,000,000 acres of swamp and overflowed land in the Mississippi valley. He argues the necessity of working out the reclamation of this land along the lines of stream control and stream guidance.

RIVERS, HARBORS AND CANALS.

The Future of the Chicago Drainage Canal Eng. News, Feb. 13, 1908; 2 1-3 pp.

Discussion of the problems which enter into the development of the present drainage channel into a deep waterway from the Great Lakes to the Gulf of Mexico

Panama Canal: Statement of Work, Equipment and Finances. Eng. News, Feb. 13, 1908; ¾ p.

Brief statement from the Isthmian Canal Commission of progress of excavation, force employed and appropriations and expenditures for the work.

Sheathing Piers on Lake Erie With Divers. By W. T. Howe. Eng. News, Feb. 20, 1908, ¾ p.

Describes method of sheathing crib piers under water with divers; gives price, organization and labor costs for representative job. An article of interest to contractors.

Rivers Conservancy and Rivers Boards. By Reginald Ryves. The Surveyor, Feb. 14, 1908; 2½ pp.

There is considerable agitation in Great Britain for the centralization of the control of the various rivers in one board, this board to have charge of matters affecting the water supply. This article treats of the advantages of including in the duties of the proposed board the care and management of the rivers themselves.

Quay Walls for the New Dry Dock at the Charleston Navy Yard. Eng. Rec., Feb. 1, 1908; 2 1-3 pp.

A description of the work done in erecting these concrete walls. The excavation in soft material was difficult, but the feature of special interest was the pile driver used for driving foundation piles, which was operated by a derrick, it having no leads. The hammer weighed 5,000 lbs.

The Flood of March, 1907 in the Sacramento and San Joaquim River Basins, California. By W. B. Clapp, E. E. Murphy and W. F. Martin. Proc. Am. Soc. C. E., February, 1908; 140 pp.

A description of the worst flood that has ever occurred in this state. The topography of the drainage area is described, with the local conditions. Numerous tables are given of the precipitation of various sections and of the flow and run-off of the various streams. One of the most complete papers on a flood that has appeared in print for some years.

"I would have given $1,000.00 for this book a year ago." —W. H. Burk, Knoxville, Tenn.

"FIELD SYSTEM"

By FRANK B. GILBRETH, M. Am. Soc. M. E.

WHO THE AUTHOR IS.—Frank B. Gilbreth is the contractor who has made the "cost-plus-a-fixed-sum-contract" famous. In order to handle contract work scattered all over North America, Mr. Gilbreth found it necessary to develop a system whereby his foremen would execute work properly, promptly and economically. The code of rules and instructions to his foremen, and the printed forms for their reports, were bound in book form, and this book Mr. Gilbreth called his "Field System." Mr. Gilbreth's contracts have covered the widest possible range. Railways, canals, dams, factories, office buildings, whole industrial towns, are among the works that he has executed.

WHY ENGINEERS SHOULD STUDY "FIELD SYSTEM."—Every engineer should know how to manage men, for, whether he confines himself to purely professional work or enters into business of executing construction work, his ambition should be to direct the men under him in a manner that will secure the greatest possible efficiency. A revolution in the art of managing men is now in progress. Direct personal supervision was once deemed essential. To-day, however, "system" is fast supplanting personal supervision. By "system" we mean printed or written directions for employes to follow, and daily reports that show what the employes have done. System of this sort has recently been extended to the field survey work of the U. S. Geological Survey. While Gilbreth's "Field System" is not a system for the management of surveys, for example, it is rich in suggestions that can be applied in the management of any kind of field work, whether employes are engaged in surveying or in construction. Its rules and methods are applicable to office work, in so far as the principles involved are concerned. The book, in brief, is a treatise on the science of managing men by system. No engineer who aims to be more than a subordinate can afford not to have this treatise, written by a man who is an acknowledged adept in managing men.

Hundreds of engineers have gone into the contracting business during the past few years, and there is room for thousands more. But if they are to succeed in any great measure, it must be by the intelligent application of system and cost analysis. Gilbreth's "Field System" does not cover the whole field, nor was it written to cover it, but it does cover a very important part of the field, and a part upon which practically nothing has ever been written.

WHY CONTRACTORS SHOULD HAVE "FIELD SYSTEM."—Mr. Gilbreth has done in contracting what Mr. W. L. Douglas and Mr. Marshall Field have done in the mercantile field. He has taken a class of work involving endless detail, and has reduced the handling of these details to a system by virtue of which economy in construction and celerity in performance are secured, regardless of place or men. Every one has heard the expression, "one-shovel contractor," meaning a contractor capable of managing only one steam shovel at a time. The "one-shovel contractor" is the antithesis of the contractor having a system. The "one-shovel contractor" receives daily reports, it is true, but his reporters are his two eyes. The "one-shovel contractor" has a code of instructions for his men, it is true, but his ready tongue is the only leaf of a code bound between the cover of two jaws. The day of the "one-shovel contractor" is not yet gone entirely, but it will pass rapidly away. Every contractor should have a field system of his own, embodying his own experiences and covering his own necessities, but in the developing of such a field system no contractor can afford not to study the work of Mr. Gilbreth.

COPIES OF "FIELD SYSTEM" STOLEN.—When it became generally known that Mr. Gilbreth had supplied his foreman and superintendents with printed instructions, copies of the book were bribed from his employes, and photographed page by page, from cover to cover. Other copies were "lost," and thus made way with entirely. Huge salaries were used to hire away Mr. Gilbreth's superintendents, for the purpose of getting not only their trained services, but for their knowledge of the contents of the "Field System."

MAKING THE BOOK PUBLIC.—Mr. Gilbreth's action in making public his "Field System" in its entirety is without precedent in the world of business. It is an act that puts contracting on the high professional level of civil engineering. The civil engineer discloses his method of designing a structure, his purpose being to assist other engineers in doing as well. In the interest of scientific advancement the engineer places on record what he has found to be economic or effective. In the same spirit—we may call it the modern American spirit—Mr. Gilbreth has permitted publication of his private code of instructions to his men—his "Field System." He believes that contractors, and, indeed, all professional business men, will become far more efficient as managers of men if such systems as this are disclosed. He believes that in the general rise of efficiency that will occur all those engaged in business will share. He believes that those who are best fitted to be leaders will remain leaders. Character, experience and ability will have the same relative weight as ever. In these beliefs every broadminded man ought to concur.

China is a nation that worships "trade secrets." It is a nation of industrial mutes. Their arts and their manufactures are taught by father to son, and zealously guarded. There has been no pyramiding of improvements upon one original invention as a base. The Chinese do not lack inventive ability. They are merely cursed by the curse of secretiveness. Their industries are plastered with signs of "No admittance," and are mummified in consequence. In striking contrast with the Chinese method is the American method. Our doctors, or engineers and our men of science generally have never concealed their discoveries or their improvements. Latterly our business men have shown a recognition of the truth of the general proposition that it pays the individual to share his discoveries with the rest of his fellows. Such generosity, in the final analysis, is simply an enlightened selfishness. The publishers of Gilbreth's "Field System" urgently request other contractors and business men to come forward with their systems, and put them permanently on record. Let business men generally adopt the altruistic policy that actuates professional men, and in its prosperity America will soon rise as far above its present level as it now stands above the level of the Chinese Empire.

PRICE OF THE "FIELD SYSTEM."—The book has 200 pages, bound in leather, and its price is $3 net, postpaid. Order now, before the edition is exhausted.

THE MYRON C. CLARK PUBLISHING CO.

355 Dearborn Street, Chicago

RAILWAYS.

Construction of the Portland & Seattle Ry. By W. P. Hardesty. Eng. News, Feb. 13, 1908; 4 pp.

This new railway is 235 miles long and this article gives a general description of the main structural features and of the construction work. The article gives a good general idea of the character and amount of the construction work with some general information about the methods adopted.

Arrangement of Railroad Shops. Con. Eng., Feb. 7, 1908; 7 pp.

A paper read before the Canadian Railway Club by Mr. George A. Damon. The paper shows several actual examples of shop arrangements, the size and equipment of shops and their cost are commented upon.

Standard Track Sections. Ry. Eng. & M. W., February, 1908; 5½ pp.

A description and cross section of about 19 different railroad standards are given. It includes nearly all the principal railroad systems in the country. Some tables made up from these sections are compiled that allow of ready comparison of the various standards.

Operating Time as an Element in Considering Grade Reductions. Eng. Rec., Feb. 1, 1908; 1½ pp.

Abstract from a paper by A. K. Shurtleff, read before the American Railway Engineering and Maintenance of Way Association. An interesting discussion of this subject, giving some tables of speed, draw-bar pull and diagrams to illustrate why operating time should be considered.

The Problem of Track Support. By Samuel E. Duff. Ry. & Eng. Rev., Feb. 22, 1908; 2½ pp.

A discussion of wooden cross tie and steel I-beam track supporting, and recommending a system in use by the Pittsburg Railway Co. of supporting the track by a continuous longitudinal steel girder and support, connected by tie rods. The method is adaptable to both T and girder rails, and cross section of such tracks are illustrated.

Areas of Contact Between Wheels and Rails. Ry. & Eng. Rev., Feb. 15, 1908; 2½ pp.

Abstracted from a book on the "Car Wheel," by Geo. L. Fowler, published by The Schoen Steel Wheel Co. Over 60 illustrations showing contacts obtained through a series of tests. Conclusions drawn from the tests are set forth.

The Electrification of the Suburban Zone of the New York Central & Hudson River Railroad in the Vicinity of New York City. By William J. Wilgus. Proc. Am. Soc. C. E., February, 1908; 30 pp.

In this paper the reasons for using electricity in this zone are given, and a description of the work, in many details, is set forth, and the considerations discussed that led up to the adoption of this class of construction, and the various details. The paper is illustrated with many diagrams, plans and photographs. There is much in the article that is of interest to both civil and electrical engineers.

Memphis & State Line Railroad. Ry. Age, Feb. 28, 1908; 6½ pp.

A general descriptive article containing a number of plans of solid floor trestles, concrete piers and abutments and concrete bridge plans that will interest railway engineers.

ELECTRIC RAILWAYS.

—Syracuse, Lake Shore & Northern R. R. By E. M. Wharff. St. Ry. Jl., Feb. 15, 1908; 3¾ pp.

General description of line with particular account of catinary overhead construction of 300-ft. spans.

Two-Story Car House, New York City Ry. St. Ry. Jl., Feb. 8, 1908; 2½ pp.

Structure interesting because of construction to store cars on two levels. Walls of brick and floors and roof of concrete. Description general in character.

Northampton Traction Co.'s System. St. Ry. Jl., Feb. 1, 1908; 4½ pp.

Gives grades and some details of track construction.

Labor Cost of Building a High Power Transmission Line. Eng.-Contr., Feb. 5, 1908; 1¾ pp.

Gives labor cost in detail and methods employed in constructing 9,500 ft. of pole line. Pole erection and wire stringing complete are recorded in all details.

The Washington, Baltimore & Annapolis Electric Railway. Elec. Ry. Rev., Feb. 15, 1908; 11 pp.

This article describes the organization of this new road, the location of the line and the country it traverses, and describes and illustrates, by photographs and drawings, the principal construction features, including the track work, the overhead construction, the shops, car barns, terminals, signaling system, rolling stock, power house and substations. Circuit diagrams are also shown. This is a double track, single phase 6,600 volts electric line between Baltimore and Washington.

Transmission Line Considered as a Mechanical Structure. By W. T. Ryan. Elec. Wld., Feb. 29, 1908; 2½ pp.

The purpose of this article is to present the equations which are made use of in the mechanical design of line in such a form that with certain duties and a reasonable allowance for practical considerations one can at once find the deflection to be allowed in the wires, diameters of pole, bending movement to be constructed by guys at curves, etc.

TUNNELS AND SUBWAYS.

The Opening of the First Hudson River Tunnel. Eng. News, Feb. 27, 1908; 3½ pp.

Gives a condensed history of the various efforts to tunnel the Hudson River at the location of the present tunnel, describes the structural features of the work and the scheme of operation. A good historical and general article.

BRIDGES AND BUILDINGS.

Formulas for Estimating Quantities of Materials in Timbers and Pile Trestles. Eng.-Contr., Feb. 12, 1908; 1 p.

Gives formulas for calculating materials in pile and timber trestles for various heights up to 125 ft., with a full discussion of the method of using the formulas and some hints on estimating costs. An unusually valuable article.

Data on Cut Stone Work. Eng.-Contr., Feb. 19, 1908; ¼ p.

Gives data on the cost of the cut stone work in the U. S. Government Printing Office at Washington, D. C.

The Weaver Drawbridge Rail Lock, Long Island R. R. Ry. & Eng. Rev., Feb. 15, 1908; ½ p.

Describes and illustrates a new method of locking a rail on a draw bridge. Working plans are shown.

A Steel Pile Foundation in a Quicksand Pocket. Eng. Rec., Feb. 22, 1908; 2-3 p.

Description of a small deep pocket of quicksand adjoining the foundation of another building. Could not be excavated, and too small for a caisson. A steel pile foundation to carry about 500 tons was designed. Plan of foundation is given and method of putting it in place is described. The work was done for a 16-story building in New York City.

The Roundhouse of the Lehigh & Hudson River Railway at Warwick, N. Y. Eng. Rec., Feb. 8, 1908; 1 2-3 pp.

A description of this building showing a number of detail drawings of track pits, standard smoke jack of the Erie R. R., a

Cements, Mortars and Concretes

—Their Physical Properties

An up-to-date Compendium of Reliable Tests of Cements, Mortars and Concretes

By

MYRON S. FALK, Ph. D.

Instructor in Civil Engineering, Columbia University.

This book contains a very complete report of the results of tests made during the past fifteen years, and gives these results in tables and diagrams classified according to subjects. This is a reference book that should be in the library of every civil engineer. The contents include chapters on Chemical Properties of Cement, Physical Tests of Cement, General Physical Properties, Elastic Properties in General, Tensile Properties, Compressive Properties, Flexural Properties, Report on Uniform Tests of Cement by the Special Committee of the American Society of Civil Engineers, and Constitution of Cement.

Cloth, 6x9 inches; 184 pages; illustrated; price $2.50 net, postpaid.

Practical Cement Testing

By

W. PURVES TAYLOR, M. S. C. E.

Engineer in Charge of Philadelphia Municipal Testing Laboratories.

This is the first practical and exhaustive treatise on this important subject. It has already been adopted as a text-book by the University of Pennsylvania and other technical schools. Each chapter contains a minute description of the methods followed in the author's laboratory and many valuable suggestions as to the "how" and "why" of cement testing. The observations on the interpretation of results, one of the most difficult tasks of the novice, are especially pertinent and are expressed in a fair and conservative manner.

The book is so complete that it can be put in the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. The wealth of photographs and line cuts furnish the pictorial examples of how to conduct cement tests, and the 300 pages of texts are so explicit that even the most inexperienced man can soon learn the art of cement testing. Yet the book has not a superfluous paragraph. The list of chapters includes: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13) Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement than Portland, (16) Specifications (The Author's, Am. Soc. C. E.; Am. Soc. Test. Mtls.; Soc. Chem. Indust.; Corps Eng. U. S. A.; British Standard, Can. Soc. C. E.).

Cloth, 6x9 inches; 330 pages; 142 illustrations; 58 tables; $3 00 net, postpaid

The Myron C. Clark Publishing Company

355 Dearborn St., Chicago

part of which system the L. & H. R. Ry. is, and other construction features.

Plate Girder Bridge, Washington, D. C. By W. J. Douglas. Eng. News, Feb. 13, 1908, 1 p.

The bridge consisted of 3 plate girders 110 ft long and 4½ ft deep. Article describes method of strengthening old masonry abutments with concrete and some interesting details of the work of hauling the girders complete across the city by wagon. Figures are given of the cost of damages paid the city for injury to pavements, etc., by the heavy loads.

The Weehawken Transfer Bridges of the West Shore Railroad. Eng. Rec., Feb. 15, 1908, 3 pp.

A description with plans and detail drawings of two timber transfer bridges to be used in handling freight cars from the terminal yards at Weehawken to scows, for entry into New York City. The article is of interest to bridge and railroad engineers.

The Bascule Bridge Between Portsmouth and Tiverton, R. I. Eng. Rec., Feb. 29, 1908; 3 pages.

This bridge, built by the state of Rhode Island over the Sakonet River, has a bascule span of 100 ft. in two leaves. It varies somewhat from the usual style of this type of bridge. The span on either side of the draw are through trusses, and on top of them are two girders upon which runs a small car that is the counterbalance of the draw leaf. This car is connected to the leaf by struts that have pivoted bearings. A number of detail plans are shown of the structure.

Some Lessons from a Cofferdam. By W. H. Broughton. Eng. Rec., Feb. 29, 1908; 1 p.

A paper read before the Ohio Engineering Society descriptive of a small cofferdam to build a bridge pier in 6 ft. of water. Troubles of varous kinds occurred and many valuable lessons were learned from it. The work is described in detail so the reader is able to profit by the experience of the contractor who did this work.

CONCRETE AND REINFORCED CONCRETE.

Spiral Anchorage for Concrete Reinforcement. By Daniel B. Luten. Eng. News, Feb. 27, 1908; 2-3 p.

Argues the necessity of special means for anchoring reinforcing bars in concrete, describes special spiral anchorage and gives computations of efficiency.

Failure of Concrete Roof of Lawrence Mass., Filter. Eng. News, Feb. 27, 1908, ¾ p.

Abstract of paper read before the Boston Society of Civil Engineers describing the motive and causes of this accident, which occurred on April 3, 1907.

Concrete at Washington, D. C., Filter Plant. Concrete, February, 1908, 2 pp.

Describes briefly construction in reinforced concrete of bins for storage of washed sand. Concrete was also used to construct large Venturi meters 72 ins. and 54 ins.

Reinforced Concrete Construction, Butler Brothers Building. By R. W. Maxton. Conc. Eng., February, 1908; 3 pp.

Continuation of article in the January number. Gives some unusually interesting designs for entrance and floor forms. Column forms can be adapted to columns of different sizes.

Factory Made Concrete. By Charles D. Watson. Conc. Eng., February, 1908; 4½ pp.

An interesting argument advocating the molding of reinforced concrete beams, sheds, columns, etc., at the factory and erecting as units in building construction. Illustrations are given of proposed units.

Use of Cement in Road Improvement. By T. H. McDonald. Rock Prod., Feb. 22, 1908; ½ p.

Describes various ways of using concrete in road improvement and gives some general

Nearly Ready

CONCRETE CONSTRUCTION
METHODS AND COST

By
Halbert P. Gillette
M. Am. Soc. C. E., M. Inst. M. E.,
Managing Editor, Engineering-Contracting
and
Charles S. Hill, C. E.,
Associate Editor, Engineering-Contracting

THIS book handles the subject of concrete construction entirely from the view-point of the ***builder*** of concrete structures. The testing of cement, the physical properties of cements and concrete, and the design of concrete structures are not considered. The aim of the authors has been to eliminate all matter not germane to the constructing end of their subject. By doing this it has been possible to crowd a vast amount of detailed information on methods and cost of concrete construction into a volume of moderate size. The book is a treatise on the ***methods and cost*** of building in ***concrete.***

WHILE concrete design is not considered, no designer of concrete can be a really good designer without having a profound knowledge of costs and of practical methods of construction. This book will be of interest therefore to every engineer and architect who is engaged in designing concrete structures. It should be of particular assistance, however, to the contractor or engineer engaged in the actual work of making and placing concrete.

THE methods given are practical methods and they are so given that the practical man can use them. The costs given are actual costs, itemized, analyzed and reduced to units. Costs of material, costs of transporting, costs of mixing, costs of placing, costs of tamping, costs of finishing, costs of forms, costs of bending and placing reinforcement, costs of waterproofing, costs of superintendence, costs of plant, interest charges, depreciation charges are all given, and to make these costs useful, the conditions and the methods of doing the work are stated in each case.

Cloth, 6 x 9 inches, 600 pages, 320 illustrations, $5 net, postpaid.

The Myron C. Clark Publishing Co.
355 Dearborn St., Chicago, Ill.

13 21 Park Row, New York, N. Y.

figures of cost of concrete culvert and abutment construction.

A Reinforced Concrete Cement Stock House. By A. Jordahl Eng Rec, Feb. 8, 1908, 3 pp.

Description, illustrated with some plans, of the new building being erected by the Vulcan Portland Cement Co., at their new plant at Longue Pointe, near Montreal, Canada. The system of reinforcement adopted for this building is a departure from the usual practice of reinforced concrete construction. The column and beam reinforcement and ties connecting the columns on opposite sides of the bins are all of structural steel shapes with riveted connections. These members are manufactured in a structural shop, shipped to the job, and, when erected, formed a self-sustaining steel skeleton frame of great rigidity and of ample strength to support the wooden forms and scaffolding, as well as the plant for handling and distributing the concrete

Progress of the Walnut Lane Bridge, Fairmont Park, Philadelphia. Eng Rec, Feb 15, 1908; 2 1-3 pp.

A description, illustrated by photographs, of the work being done on the main arch of this bridge, the span of which, 233 ft., is the longest in the world for concrete construction. A description of the centering and the method of keying it with the assistance of water, so that, as the concrete sets and the water dries out of the timbers, they shrink from one another, is of interest

Timber Pile Protection in San Diego Bay. Eng Rec, Feb. 15, 1908; ½ p

A description, illustrated with a drawing, of the method used to protect piles of wharves in this harbor from limnoria by means of concrete. This work cannot be done for several months after the piles are placed, as the pile must be allowed to swell before placing the concrete.

Concrete in Compression and a Discussion of Column Design. Eng-Contr, Feb. 26, 1908, 2 1-3 pp.

Reprint from January "Journal Worcester Polytechnic Institute" giving plainly and simply the behavior of concrete in compression and a brief discussion of column design. The stresses allowed in columns by various government and municipal regulations are stated.

Steel Centers and Lagging for Constructing Concrete Lining for Tunnels. Eng.-Contr., Feb. 26, 1908; ¾ p.

Describes and gives dimensioned drawings of steel ribs and steel channel lagging used by Geo. W. Jackson, Contractor, for lining waterworks and other tunnels constructed by him. The centering is an interesting one in several particulars.

Investigations of Impermeable Concrete. By James L. Davis. Eng.-Contr., Feb. 16. 1908; 1½ pp.

General account of studies made at the laboratory of the Board of Water Supply, New York, N. Y., to determine means of rendering concrete impervious to water. Studies show that the addition of from 5 to 10 per cent colloidal clay for an equal weight of sand or 2½ to 5 per cent potash alum to mixing water under concrete impervious, that five sand motives, rich in cement are more impervious than others and that permeability decreases with time due to "sitting up."

Costs of Constructing Reinforced Concrete Trestle and Three Girder Bridges. Eng.-Contr., Feb. 5, 1908; 2 pp.

The trestle was for coal storage and 114 ft. long and the bridges ranged in span from 10½ to 16 ft. Detail drawings of trestles are given. Methods of construction are described and itemized unit costs are given for such structure.

Reinforced Concrete from the Contractor's Standpoint. By Henry H. Fox. Eng.-Contr., Feb. 5, 1908; 3 1-3 pp.

An excellent general paper giving hints on construction methods for reinforced concrete building work. Sketches of form construction and hoisting plants are given. A valuable paper by a practical construction superintendent.

Wall Form Clamp and Wall Tie for Concrete Work. Eng.-Contr., Feb. 5, 1908; ½ p.

Illustrates and describes a combined wall form clamp and wall tie with brief description of the method of using them.

Metal Lagging for Concrete Forms and for Sewer Centers. Eng.-Contr., Feb. 12, 1908; 1 p.

Describes and illustrates a special metal laggard showing its application to wall forms and sewer centers and describing its use in sewer construction at Brooklyn, N. Y.

Method of Underpinning an Engine Foundation. Eng.-Contr., Feb. 12, 1908; ½ p.

Describes method of underpinning an unstable foundation for a steam engine by getting down well casings and filling and capping them with concrete.

Specifications for Cement Sidewalks. Eng.-Contr, Feb. 5, 1908; 1 p.

Reprint of the specifications submitted at the annual convention of the National Cement Users Association and adopted by the association.

Concrete Pipe Protection for Piles in Teredo Infested Waters. Eng.-Contr., Feb. 12, 1908, 1 p.

Describes method of molding and applying lock-joint concrete pipe pile protection to trestles on the Charlotte Harbor & Northern Ry. This pipe is made in two pieces which fasten together with a key so that it can be applied to capped piles

Methods and Cost of Constructing Reinforced Concrete Poles. Eng.-Contr., Feb. 26, 1908, ½ p

Letter by F. J. Hunt describing method of molding and erecting reinforced concrete poles for a power transmission line in Illinois and giving some general figures of cost.

Reinforced Concrete Diaphragms for Earth Dams. By B. M. Hall. Eng. News, Feb. 6, 1908; ½ p

Describes briefly the reinforced concrete diaphragm or core wall built in the Avalon Dam of Carlsbad, N. Mex., work of the U. S. Reclamation Service.

Traveling Mold for Making Reinforced Concrete Pipes. By F. Teichman. Eng. News, Feb 20, 1908, 1¾ pp

The author who designed these traveling molds for constructing reinforced concrete pipe for the Salt River irrigation work in Arizona describes their design and operation in some detail. Possible improvements are also discussed.

Ferro-Concrete Highway Bridges. The Surveyor, Feb. 7, 1908; 4½ pp.

A number of examples of ferro-concrete highway bridges recently constructed in England are described briefly in this article. Various drawings of the different bridges are shown, and practically all the types of bridge design likely to be required by highway authorities are covered by the article.

MATERIALS OF CONSTRUCTION.

Tests to Determine the Effect of Mica on the Strength of Concrete. By W. N. Willis. Eng News, Feb 6, 1908; ½ p

Tests were made on 1-3 mortars of cement and standard sand and cement, sand and mica in percentages of from 2½ to 20 per cent by weight of sand. Diagrams show the reduction in strength in pounds per square inch and in percentages of strength of cement and sand mixture for periods of 7 days to 6 months.

SURVEYING AND DRAFTING.

Bench Level Operations on the Catskill Aqueduct Line. By M. E. Zipser. Eng. News, Feb 20, 1908; 1 2-3 pp

Describes the instruments used and the methods adopted in running bench levels for some 60 miles of the Catskill aqueduct. The

Rock Excavation
Methods and Cost
By
HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting."

One superintendent who purchased this book about a year ago writes us that he has cut the cost of his drilling and blasting practically in two since he received the book and applied the methods given by Mr. Gillette. We doubt whether such a statement has ever before been truthfully made of any books except those written by Mr. Gillette. His books are practical books for practical men, and the keynote throughout is economy—how to save money on the work and how to increase the output.

"Rock Excavation" has chapters describing:

Rocks and Their Properties.
Methods and Cost of Hand Drilling.
Machine Drills and Their Use.
Steam and Compressed Air Plants
The Cost of Machine Drilling.
Cost of Diamond Drilling.
Explosives.
Charging and Firing.
Methods of Blasting.
Cost of Loading and Transporting Rock.
Quarrying Stone.
Open Cut Excavation.
Methods and Costs on the Chicago Drainage Canal.
Cost of Trenches and Subways.
Subaqueous Excavation.
Cost of Railway Tunnels.
Cost of Drifting, Shaft Sinking and Stoping.

Cloth, 5¼x7 in., 384 pages, 56 figures and illustrations; $3 net postpaid.

Earthwork
And Its Cost
By
HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting."

A book that should be in the hands of every man who is in charge of "moving dirt," whether with pick and shovel, plow and scraper, steam shovel and dredge, or any other tool for digging and conveying earth. The contents include:

The Art of Cost Estimating.
Earth Shrinkage.
Earth Classification.
Cost of Loosening and Shoveling.
Cost of Dumping, Spreading, Rolling.
Cost of Wheelbarrows and Carts.
Cost by Wagons.
Cost by Buck and Drag Scrapers.
Cost by Wheel Scrapers
Cost by the Elevating Grader.
Cost by Steam Shovels.
Cost by Cars.
How to Handle a Steam Shovel Plant.
Summary and Table of Costs.
Cost of Trenching and Pipe Laying.
The Cost of Hydraulic Excavation.
Cost of Dredging.
Miscellaneous Cost Data.
Earth and Earth Structures.
Rapid Field and Office Survey Work.
Overhaul Calculation.
A Small "Home Made" Dipper Dredge or Steam Shovel.
Detailed Description and Drawings.
Cost of Making the Dredge.
Cost of Operating.

Cloth, 5x7¼ in., 260 pages, 50 figures and illustrations; $2.00 net postpaid.

The Myron C. Clark Publishing Co.
335 Dearborn St., CHICAGO

structural bench marks used is illustrated. Rules of [illegible] the merits of different instruments and methods are stated.

Replacing Broken Cross Wires in Field Instruments. Eng.-Contr., Feb. 26, 1908; 1-3 p.

Gives method of replacing broken cross wires in field instruments with spider's web.

Cost of a Railway Survey. Eng.-Contr., Feb. 19, 1908; 1-3 p.

Gives the actual costs of making preliminary and location surveys for a railway in Canada.

A System of Filing, Engineering Notes and Records. Eng. Rec., Feb. 8, 1908; 2½ pp.

An account of the office system in use by the city engineer of Salt Lake City, Utah. System of conducting work and of filing reports described, and several blank forms for recording work done, are illustrated. Method of filing drawings described, and also of photographs taken to show progress of work being done for the city.

EARTH AND ROCK EXCAVATION.

Cost of Laying 6 and 8-in. Wrought Iron Screw Joint Pipe. By E. E. Harper. Eng. News, Feb. 27, 1908; 2-3 p.

There were 7,000 ft. of 8-in. and 4,000 ft. of 6-in. pipe for a compressed air line. Method of laying is described and detailed costs are given of the work. A valuable article for contractors.

Sinking a Five-Compartment Shaft on the Rand. By Eustace M. Weston. Eng. & Min. Jl., Feb. 22, 1908; 5 pp.

Describes the character of the ground through which shaft was sunk, and methods of doing the work, giving many details and some costs on two of the shafts.

The Estimated Cost of the Ashokan Reservoir and Data of Actual Cost of Similar Earth Embankments, Together with a Discussion of the Testimony Submitted in the Investigation of the Ashokan Dam Award. Eng.-Contr., Feb. 12 and 19, 1908; 8 pp.

Showing that the issue raised in this investigation was the one of using cost analyses in making up estimates. A synopsis of evidence submitted in the case is given and much valuable cost data on the actual building of reservoir embankments. An analysis of the estimated cost of the earth work at Ashokan is shown in detail. The list of expert engineers employed by New York City to give advice to the Commissioners of Accounts is given, together with a sketch of the work they had done as engineers. The bids submitted for the Ashokan dam are given, showing the unit prices and aggregate bid.

Thawing Explosives. By P. N. Denison. Rock Prod., Feb. 22, 1908; 2-3 p.

Presents the dangers of frozen dynamite and describes various methods of thawing it with the greatest degree of safety. Of interest to quarrymen and contractors.

The Estimated Cost of the Main Ashokan Dams. Eng. Rec., Feb. 15, 1908; 4 pp.

An account of the controversy regarding the cost of the earthwork at Ashokan, with some consideration given as to reasons set forth by the engineers of the Board of Water Supply in defense of their estimated cost of the work.

The Use of a Water Jet to Increase the Speed of Rock Drilling and a Formula Estimating the Amount of Water Necessary. Eng.-Contr., Feb. 5, 1908; 1 p.

Attention is called to the use of the water jet in drilling rock and a rule and formula is given for estimating the amount of water needed to wash out the sludge. The method of deriving the formula is given. This is invaluable to engineers and contractors doing rock excavation. The formula is:

[illegible]

Q = gallons of water per minute.
D = diameter of drill hole in inches.
d = diameter of largest grains of sludge in inches.

Steam Scraper Work. Eng.-Contr., Feb 26, 1908; 1-3 p.

The world's authority on this great subject.
The most expensive book ever issued and sold for $5.00.

Concrete and Reinforced Concrete Construction

By HOMER A. REID, Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; $5 net, postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete, on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter — material never previously published. This work is complete, up-to-date and original. No other book on concrete contains one-tenth so much of the very latest data on tests, theory and practice.

In a two-column review of this book, "Manufacturers' Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

Write for 16-page Table of Contents.

THE MYRON C. CLARK PUBLISHING CO.
(NOT INCORPORATED)
355 Dearborn St. CHICAGO

Describes method of using scrapers hauled by steam hoist in excavation work.

The Cost of Doing Scraper Work in Freezing Weather. Eng.-Contr., Feb. 12, 1908; 1-3 p.

The itemized cost of excavating earth with wheel scrapers during the winter in the state of Maine is given in the article. In order to keep the ground from freezing the plow team was worked day and night.

The Cost of Digging a 36-Mile Trench with a Buckeye Traction Ditcher. Eng.-Contr., Feb. 12, 1908; 3/4 p.

An account of digging a trench 4 ft. deep and 30 in. wide nearly 36 miles long is given, and the cost of digging per lin. ft. of trench with the machine, and also per cu. yd. is recorded. This is the most complete cost record on trench excavation, with a machine, that has ever been published.

The Cost of Earth Excavation with Wagons During Winter Weather. Eng.-Contr., Feb. 5, 1908; ½ p.

The detail cost of excavating earth and hauling it in wagons 2,500 lin. ft. during the winter season is given. The work was done in grading a railroad. A comparison is made with some work done during good weather.

Rapid Coffer Dam Construction. By Chas. M. Ripley. Eng.-Contr., Feb. 15, 1908; 2 pp.

A description of the coffer dams used in constructing the foundations for the power plant of the Economy Light & Power Co. above Joliet, Ill.

Labor Cost of Building a High Power Transmission Line. Eng.-Contr., Feb. 5, 1908; 1 2-3 pp.

The detail costs of each item of work is shown in building a line not quite two miles long. Among the various items is given the cost of digging the holes for the poles, the record having been kept to show the cost per hole and the cost per cu. yd. of earth excavated.

Machine vs. Hand Drilling in Sinking on the Rand. By Eustace M. Weston. Eng. & Min. Jl., Feb. 29, 1908; 3½ pp.

The writer states that hand drilling is preferred on the Rand for shaft sinking, and gives the usual reasons that advocates of that method use in defending it. Then he states his preference for machine drilling, and shows why it is to be preferred both for rapid and for economical work. He gives some records to substantiate his position, and some good suggestions on shaft sinking.

Cost Data on Earth Excavation and on Rubble Masonry and Methods of Recording the Same. By C. A. Sawyer, Jr. Eng.-Contr., Feb. 26, 1908; 1 p.

Gives the cost of excavating a building foundation, also of building this foundation of rubble masonry. From such data the author deduces a factor of cost, showing in decimal parts of an hour the time necessary to do a given unit of work, then by using as another factor, the wage rate per hour, he obtains the total cost per unit.

The Original Estimate of the Ashokan Reservoir Made by the Burr-Hering-Freeman Commission. Eng.-Contr., Feb. 26, 1908; ½ p.

Showing the estimated cost of the earthwork for the various structures to be built in connection with the Catskill water supply, the Ashokan dam being one of the important structures. A comparison is made with the bid prices of the lowest bidder, whose bid was rejected as being too low, showing that for most items of earth work these engineers estimated a less price than was bid.

The Cost of Grading a Wagon Road in Winter. Eng.-Contr., Feb. 26, 1908; 1½ pp.

Giving the itemized cost of grading the road, part of the time the ground having to be thawed with wood fires. Also the cost of placing oyster shells on the road as a metal covering. Comments are made on the cross section of the road, showing an economical section that should be used for most roads.

MISCELLANEOUS.

Pile Driving Experiments at Charles River Dam. Eng.-Contr., Feb. 19, 1908; 2 pp.

Gives results of redriving tests on piles that had risen after driving. Results are given in tables and diagrams. An interesting investigation.

Tests Showing Effect of Hammer Rope in Decreasing Effectiveness of Pile Hammer Blow. Eng.-Contr., Feb. 19, 1908; 1-3 p.

Gives results of series of tests showing that a decrease in penetration of some 15 per cent results from retarding effect of hammer rope.

Tests of Wire Rope. By W. Martin Epten. Rock Prod., Feb. 5, 1908; 2-3 p.

Gives results of series of 90 tests of wire steel hoisting ropes.

Cost of Briquetting Coal. Eng.-Contr., Feb. 19, 1908; 1-3 p.

Cost data on the manufacture of fuel briquettes from anthracite coal dust and coal tar pitch.

Table of Short Radius Curves. By E. W. Hess. Eng. News, Feb. 6, 1908; 1-6 p.

Table giving chord, central angle, deflection angle, and deflection for 1 ft. for radius from 35 ft. to 410 ft. A useful table in trolley line, curved street line and pipe line work.

Design and Construction of Automatic Car Systems. By Chas. J. Steffens. Eng. News, Feb. 13, 1908; 2½ pp.

A good article on the design, equipment and construction of automatic dump car systems for handling coal, gravel, broken stone, etc. Illustrations are given of individual derrick, dump cars and trestle and track construction. The article is of value to contractors.

The Preservation of Piling Against Marine Wood Borers. By C. Stowell Smith. Forest Service Circular 128; 12 pp.

A pamphlet completely covering this important subject in a very intelligent manner. Describes and illustrates the various borers, and tells of their manner of attack. Shows various methods tried to prevent destruction of piles by borers and states the efficiency of these methods.

A Primer of Wood Preservation. By W. F. Sherfesee. Forest Service Circular 139; 12 pp.

A valuable pamphlet treating of the A B C of wood decay and how to prevent it. Showing the effect of seasoning and chemical impregnation to prolong the life of timber. Tells of the four methods of timber treatment in most common use, and illustrates by several examples the saving in dollars and cents effected by wood preservation.

Over 10,000 copies of this book were sold in less than 2 years, thus breaking all records for the sale of a technical book.

HANDBOOK OF COST DATA

By HALBERT P. GILLETTE, M. Am. Soc. C. E.
Editor ENGINEERING-CONTRACTING

This book was written by an experienced contractor and engineer, and contains just the class of information that men usually keep carefully concealed under their hats. It has over 600 pages of actual records, showing the detailed cost of doing various classes of work under different conditions. *The entire book is filled with figures and facts that are invaluable to anyone interested in contract work or construction of any kind.*

Flexible leather, gilt edges, 622 pages, illustrated; $4.00 net postpaid

24-page circular, giving information concerning the contents of each section, together with sample pages, will be mailed FREE.

WRITE FOR IT.

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

WANTED
Engineers, Electricians
and all users of Steam and Electricity. New 25-page booklet containing the Questions asked by different Examining Boards throughout the country.
SENT FREE
GEO. A. ZELLER BOOK CO.
6 South 4th Street, ST. LOUIS, MO.

SEND A POSTAL

for catalogs of new books for engineers and contractors. Better do this

TO-DAY

and have them handy for future reference.

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

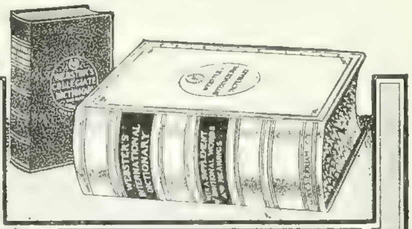
Railroad Location Surveys and Estimates

By F. LAVIS, M. Am. Soc. C. E.
Resident Engineer, Pennsylvania Railroad Tunnels, Formerly Locating Engineer, Choctaw, Oklahoma & Gulf Railroad, etc.

The "Railroad Gazette" says: "Once in a while a scientific book appears that combines the threefold elements of mastery of the subject, clearness of expression and elegance in the use of English, a combination as rare as it is attractive. The book at hand is of this sort, and the interest of the reader or student is held through every line of the text. *It is one of those rare productions in which there is not a wasted word and whose scientific value is high in that it tells clearly and concisely just what every student and engineer should know.*"

Cloth, 6 x 9 in., 270 pages, 73 illustrations, 10 folding plates; $3 net, postpaid

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.



WEBSTER'S INTERNATIONAL DICTIONARY

A LIBRARY IN ONE BOOK.
Besides an accurate, practical, and scholarly vocabulary of English, enlarged with 25,000 NEW WORDS, the International contains a History of the English Language, Guide to Pronunciation, Dictionary of Fiction, New Gazetteer of the World, New Biographical Dictionary, Vocabulary of Scripture Names, Greek and Latin Names, and English Christian Names, Foreign Quotations, Abbreviations, Metric System, Flags, Seals, Etc.
2380 Pages. 5000 Illustrations.
SHOULD YOU NOT OWN SUCH A BOOK?
WEBSTER'S COLLEGIATE DICTIONARY.
Largest of our abridgments. Regular and Thin Paper Editions. 1116 Pages and 1400 Illustrations.
Write for "The Story of a Book"—Free.
G. & C. MERRIAM CO., Springfield, Mass.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0606. **Steel Sheeting.**—Geo. W. Jackson, Inc., Chicago, Ill.

This handsome 68-page pamphlet is devoted very largely to illustrations of foundations, tunnel, shafts, trench work, etc., in which the two styles of steel sheeting manufactured by the above named firm have been used. The style of this sheeting consists of a composite member made up of two channels which is alternated with an I-beam member. This is claimed to be an entirely water tight sheeting and is used for heavy work where the weight of water is very great. The second type of sheeting consists of I-beams which are interlocked by means of clamps or clips which are bolted to them. This is a light sheeting designed for work in which water-tightness is not absolutely essential.

No. 0607. **Hammer Drills.**—Sullivan Machinery Co., Chicago, Ill.

This bulletin illustrates and describes in some detail the special hammer drill for mining work which is manufactured by the company named. Quite full details of the construction and operation are given and the various advantages of the drill for mining work are explained.

No. 0608. **Smokeless Furnaces.**—Murphy Iron Works, Detroit, Mich.

This 39-page pamphlet describes and illustrates the construction and operation of the Murphy Automatic Smokeless Furnace. This furnace has been on the market for a great many years and is so familiar to steam engineers that its description does not need to be enlarged upon. The pamphlet shows such details of the construction and operation as are necessary to a thorough understanding of its action and will be of interest to every engineer not already familiar with the device.

No. 0609. **Water Softening Plants.**—Kennicott Water Softener Co., Chicago Heights, Ill.

This elaborate 68-page pamphlet describes and illustrates by means of half-tones and line-drawings, the construction and operation of such a typical water softener plant of the type installed by the above named company. Accompanying the pamphlet is a pamphlet of diagrams and instructions which are of interest to water supply engineers for railways.

No. 0610. **Rotary Disc Plow.**—Disc Grader and Plow Co., Hunter, North Dakota.

The disc plow manufactured by the above company is already quite well known by contractors. It is a special type of plow designed for very hard soil, and this pamphlet describes and illustrates it in detail. It will be of interest to contractors to secure the pamphlet and read it.

No. 0611. **Asphalt Filler.**—Standard Asphalt and Rubber Co., Chicago, Ill.

This well printed pamphlet of 22 pages explains the value and use of asphalt as a filler for brick and other pavements. The character of the special filler used is described, directions are given for applying it and illustrations and descriptions are given of the various devices and tools used. The pamphlet is of interest to street paving contractors.

No. 0612. **Concrete Blocks.**—The Queen City Block Manufacturing Co., Traverse City, Mich.

The block machine described in this pamphlet is of the automatic face-down type; sizes of blocks and general catalogue information are given.

No. 0613. **Unclimbable Fences.**—Anchor Post Iron Works, New York City, N. Y.

This pamphlet describes a special wire mesh fence for factory grounds and other places where a fence that can not be climbed is desired. The company also manufactures wire railings and fencing and wire mesh for general farm and other purposes.

No. 0614. **Trench Steam Shovel.**—Vulcan Iron Works Co., Toledo, Ohio.

This pamphlet illustrates the use of the smaller shovels manufactured by the above named company, in digging sewer trenches. Line drawings are given, showing the method of mounting the shovel and bracing the trench. This type of work is further illustrated by half-tones of shovels in actual operation.

No. 0615. **Railway Track Supplies.**—Kalamazoo Railway Supply Co., Kalamazoo, Mich.

This is the general catalogue of track and railway supplies manufactured by the firm named above. It consists of 140 pages with an index and lists and gives the usual catalogue information regarding the great variety of track tools and devices manufactured and sold by the company. Among the special devices are track drills, velocipedes and handcars, track jacks, rail benders, and steel water tanks and towers.

No. 0616. **Trucks.**—Standard Scale Supply Co., Chicago, Ill.

This 16-page pamphlet is devoted largely to trucks and cars for handling merchandise. Some of the tools shown are desirable for contractors and the pamphlet will prove of interest to this class of men.

No. 0617. **Concrete Block Machines.**—P. B. Miles Mfg. Co., Jackson, Mich.

This 75-page pamphlet is devoted to descriptions and illustrations of the block machine manufactured by the company named, and a great variety of patterns of blocks is shown; also a large number of illustrations of block buildings. The text describes the various illustrations and tells how to make concrete blocks and gives an estimate of the cost of block manufacture.

No. 0618. **Duralite Concrete Forms.**—The Duralite Co., 42 Broadway, New York.

A pamphlet of 11 pages describing this patented steel form for concrete, for sewers, foundations, walls, etc. For arches no braces or supports are needed. Said to be eocnomical for any shape of sewer. Illustrations in the catalog are mostly line drawings.

No. 0619. **Railroad, Miners', Machinists' and Lumber Mill Supplies.**—Handlan-Buck Mfg. Co., St. Louis, Mo.

A flexible leather bound catalog of 640 pages, 5½x7½ ins., almost amounting to an engineer's and contractor's handbook of tools, machines and various supplies needed in railroad construction and operation. Also for mining work, for machine shops, lumbering and saw mills. List prices are given for most tools and machines. It would be impossible to list the articles shown in this catalog. The Handlan-Buck Co. are not only selling agents for many manufacturers but they also make many of the articles shown in their catalog. Anyone stating his business in writing, can obtain one of these catalogs free.

No. 0620. **Corrugated Metal Road Culverts.**—Lyle Corrugated Culvert Co., Lyle, Minn.

The metal culvert pipe described in this interesting pamphlet is made of corrugated sheet iron of a special rust resisting composition. The corrugations run around the pipe, making it stiff under load. Comparative load tests of corrugated and plain pipe are given and numerous letters from road engineers speaking of the durability and economy of corrugated pipe culverts are printed.

Personals.

Mr. J. H. Weatherford has been re-elected City Engineer of Memphis, Tenn.

Mr. Ben D. Fox, for the past two years City Engineer of Pittsburg, Kan., has resigned from that position.

Thomas F. Ryan, a railroad contractor of Kansas City, Mo., died Feb. 21, at his home in that city, aged 63 years.

Mr. Harold N. Wallace has resigned as President of the Wallace-Coates Engineering Co. of Chicago to become General Manager of the Chicago, Lake Shore & South Bend Ry. Co., a new single phase electric line.

The Appalachian Engineering Association has elected the following officers for the ensuing year: President, Mr. A. Wagner; Vice-President, Mr. Ray V. Hennen; Treasurer, Mr. R. H. Buchanan; Secretary, Dr. Henry M. Payne.

Capt. Francis A. Pope, Corps of Engineers, U. S. Army, has been relieved from duty at the United States Military Academy and will proceed to Fort Mason, Cal., where he will report on April 15 to the commanding officer, First Battalion of Engineers, for assignment to the command of Company A of that battalion.

Mr. Theodore Starrett, for many years partner in the firm of Thompson-Starrett Co., engineers and contractors, has retired from that company and has opened offices at 2 Rector St., New York City, where he will engage in practice as adviser and consulting engineer in building construction and the management of construction operations.

The firm of Morton & Burritt, Engineers, consisting of Mr. Walter S. Morton, formerly of Hartford, Conn., and Mr. Wilmot W. Burritt of New York City, has opened new offices at Two Rector St., New York. The firm will engage in general engineering business, especial attention being given to projects pertaining to water powers, water supply, reservoirs, sewerage systems, drainage, irrigation and reinforced concrete.

The Reinforced Concrete Construction Co., Cleveland, O., will hereafter carry on a business of general contracting and will change its name to the Crowell & Sherman Co. In order to handle its reinforced concrete construction with the same efficiency as before, it has merged that part of its business with the Ferro Concrete Construction Co., of Cincinnati, and in the future all concrete work, whether under separate contract, or incidental to its general contracts, will be executed by that latter, company offices being maintained in Cincinnati and Cleveland.

James Dun, Consulting Engineer to the Atchison, Topeka & Santa Fe Ry., with headquarters in Chicago, Ill., died Feb. 23, at St. Augustine, Fla., where he had gone for his health. Mr. Dun was born in Ohio in 1844, entering railway service in 1866 as chainman on the Indianapolis & Cincinnati R. R. He was Assistant Engineer of the Atlantic & Pacific Ry. from 1867 to 1871. The next three years he was Assistant Engineer with the Missouri Pacific Ry. Later he was Chief Engineer of the St. Louis & San Francisco R. R., and in 1890 became Chief Engineer of the Atchison, Topeka & Santa Fe Ry., remaining with this road until his death.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER,
CHAS. S. HILL,
C. T. MURRAY,
F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class matter April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

The Inland Waterways Commission Report 149

CONCRETE SECTION:

Special Methods Employed in Tearing Out Old Concrete Roadbed for Cable Railway and Rebuilding for Electric Railway 150
Methods and Cost of Constructing and Erecting Reinforced Concrete Poles.151
Cost of Constructing Street Railway Track with Rubble Concrete Base at Ft. Wayne, Ind. 152

EARTH AND ROCK SECTION:

Methods of Thawing Explosives.....153
Cost of Excavating Trenches by Hand for Electrical Conduits in Baltimore, Md. 154

GENERAL ARTICLES:

The Meaning of the Expression Approximate Estimates in Specifications 155
A Study of Roof Trusses..........158
A Recording Water Gage for Rivers, Reservoirs, Tanks, Boilers, etc.....160

METHODS AND COSTS:

Rolling Reservoir Embankment—Tunnel Alignment—Eight Hour Laws..157

The Inland Waterways Commission Report.

The Inland Waterways Commission, appointed a year ago to outline a plan for improvng the waterways of the United States, has made its preliminary report. This report does little more than state the problem. To those who had hoped for something definite and conclusive in the way of plans it will doubtless be disappointing. A little thought, however, will, we think, show that nothing more could have been expected. The commission had, in the first place, no legislative existence, and it had no funds with which to work. The problem before it is, moreover, not the task of a day, it is one of a magnitude seldom equaled even in national works. To state it clearly even is a task of no mean magnitude, and this the commission has at least done, and it has gone a step further and recommended a way for promoting further work.

The prominent portions of the commission's report are, briefly, the general statement of the problem to be solved and the recommendation of a means for developing its solution. The improvement of inland waterways is not merely a question of developing them into channels for navigation. This is a statement that ought not to need emphasis, but we believe, nevertheless, that it does. We are certain that a goodly number even of engineers and contractors who have thought at all of the plan of Federal improvement of waterways have thought of it solely as a plan for developing navigation routes. In presenting clearly the fact that its service as a carrier is but one of a number of useful services to the people that a stream may perform, the commission has done much needed work. In summing up the report, President Roosevelt has the following to say on this point:

"The report rests throughout on the fundamental conception that every waterway should be made to serve the people as largely and in as many different ways as possible. It is poor business to develop a river for navigation in such a way as to prevent its use for power, when by a little foresight it could be made to serve both purposes. We cannot afford needlessly to sacrifice power to irrigation, or irrigation to domestic water supply, when by taking thought we may have all three. Every stream should be used to the utmost. No stream can be so used unless such use is planned for in advance. When such plans are made we shall find that, instead of interfering, one use can often be made to assist another. Each river system, from its headwaters in the forest to its mouth on the coast, is a single unit and should be treated as such. Navigation of the lower reaches of a stream cannot be fully developed without the control of floods and low waters by storage and drainage. Navigable channels are directly concerned with the protection of source waters, and with soil erosion which takes the materials for bars and shoals from the richest portions of our farms. The uses of a stream for domestic and municipal water supply, for power, and in many cases, for irrigation, must also be taken into full account."

The position taken by the commission is interesting not only because it is economically sound, but because it makes clear that the task of waterways improvement that lies before the people is of great magnitude and complexity. It will not be the work of a year, or even a generation. Knowing this, how is it best to begin and to prosecute the work? It is not surprising to note that in the answer to this question the commission is not wholly agreed. The report reads as follows:

"We recommend that the Congress be asked to make suitable provision for improving the inland waterways of the United States at a rate commensurate with the needs of the people as determined by competent authority; and we suggest that such provision meet these requisites, viz.: expert framing of a definite policy; certainty of continuity and co-ordination of plan and work; expert initiative in the choice of projects and the succession of works; freedom in selection of projects in accordance with terms of co-operation, and the widest opportunity for applying modern business methods.

We recommend that the Congress be asked to authorize the co-ordination and proper development of existing public services connected with waterways; and we suggest that such enactment might provide that the President of the United States be authorized, with the advice and consent of the Senate, to appoint and organize a national waterways commission to bring into co-ordination the Corps of Engineers of the Army, the Bureau of Soils, the Forest Service, the Bureau of Corporations, the Reclamation Service, and other branches of the public service in so far as their work relates to inland waterways, and that he be authorized to make such details and require such duties from these branches of the public service in connection with navigable and source streams as are not inconsistent with law; the said commission to continue the investigation of all questions relating to the development and improvement and utilization of the inland waterways of the country and the conservation of its natural resources related thereto, and to consider and coordinate therewith all matters of irrigation, swamp and overflow land reclamation, clarification and purification of streams, prevention of soil-waste, utilization of water-power, preservation and extension of forests, regulation of flow and control of floods, transfer facilities and sites and the regulation and control thereof, and the relations between waterways and railways; and that the commission be empowered to frame and recommend plans for developing the waterways and utilizing the waters, and as authorized by Congress to carry out the same through established agencies when such are available in co-operation with states, municipalities, communities, corporations and individuals in such manner as to secure an equal distribution of costs and benefits."

In a supplementary report General Mackenzie, Chief of Engineers, U. S. A., one of the commissioners, notes his disagreement with the above recommendation of the appointment of a permanent inland waterways commission and expresses his belief that the work "can be equally well

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

provided for by the existing agencies of the Government." We may perhaps read between the lines of this statement the feeling that the work should not be allowed to get out of the hands of the army engineers and into the hands of a civilian commission. It is too early to argue this matter at length, but it seems to us, and we think it will appear clear to engineers in general, that if the work is to be done it should be done by such independent body as the present commission recommends in its report. Meanwhile, we have only a small prospect that Congress will at its present session do anything with the matter of inland waterways improvement beyond the usual pork barrel legislation, much less take up favorably and push forward such far-reaching legislation as the Inland Waterways Commission's report recommends.

Plans for barge canal work involving the expenditure of over $5,000,000 have been approved by the New York State Canal Board. The plans are embodied in three contracts as follows: No. 20, dredging the Mohawk river from Rexford Flats to Mindenville at an estimated cost of $3,480,000; No. 64, improving the canal in Orleans county at an estimated cost of $1,307,000; No. 45, damming the Oneida River at Caughdenoy and constructing a lock at Baldwinsville at an estimated cost of $425,000.

On Feb. 10, the total amount of material removed on the Culebra Division of the Panama Canal was 50,784 cu. yds. with 46 shovels, an average of 1,104 cu. yds. per shovel for the 8-hour working day. This material was loaded on 1,584 Lidgerwood flats, 1,199 Western dump cars (small), and 262 Western dump cars (large), and hauled an average distance of about ten miles. Three hundred and fifty-two trains were handled by 134 locomotives, divided as follows:

Serving steam shovels....	88
Switching	10
In use with spreaders.................	8
In use with Lidgerwood unloaders.....	10
In use with track shifters..............	3
In use with labor trains...............	3
In use coaling shovels..................	2
In use with work trains................	10
Total	134

The New York State Department of Health has issued a report on the workings of every sewage disposal plant in the state. More than 50 plants were examined. In the report municipal plants are divided into two classes—complete plants and partial treatment plants. According to the report the oldest complete plant is the one at Brewster, erected in 1893. The oldest types of plants for partial treatment were those found in Dolgeville, Saugerties, Bronxville and Skaneateles.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Special Methods Employed in Tearing Out Old Concrete Roadbed for Cable Railway and Rebuilding for Electric Railway.

The special machines and methods described here have effected a substantial reduction of cost in recent work being done by the United Railroads of San Francisco in changing its cable lines to electric lines on portions of its system. The roadbed construction of the old cable lines consisted of about the usual construction of iron yokes carrying the rails and cable slot and embedded in concrete molded to form the cable duct. The old yokes, rails, slot and cable duct had, of course, to be torn out: the new trolley road track consisted of girder rails in wooden cross-ties ballasted and paved over. For ballast it was planned to recrush the concrete taken out of the old cable road and so far as possible not to disturb the old concrete forming the bottom of the cable conduit, but to have it as a foundation for the ballast. The mode of procedure was as follows:

The pavement was first removed the full width of the roadbed and the track rails and slot rails were cut loose by chiseling off the bolt heads with flogging chisels. A trench about 18 ins. deep was excavated on each side of the track and the ends of the yokes laid bare by cleaning off the concrete with steel gads and hammers. This was to permit a hoisting chain or link to be caught under the yoke ends. Figure 1 shows the arrangement of the hoisting tackle, and the manner of operating it, with the electrically operated derrick car. The action was, as will be seen, to tear loose the yokes and break down the sides of the cable conduit without disturbing the bottom concrete. When the yokes had been broken loose as described, the lifting lever was unslung and the derrick hook was attached to the yokes one at a time, and they were pulled clear of the concrete and deposited to one side. As a rule the yokes pulled out clean, but when lumps of the concrete remained attached they were easily broken loose by a few blows from a sledge while the yoke was suspended.

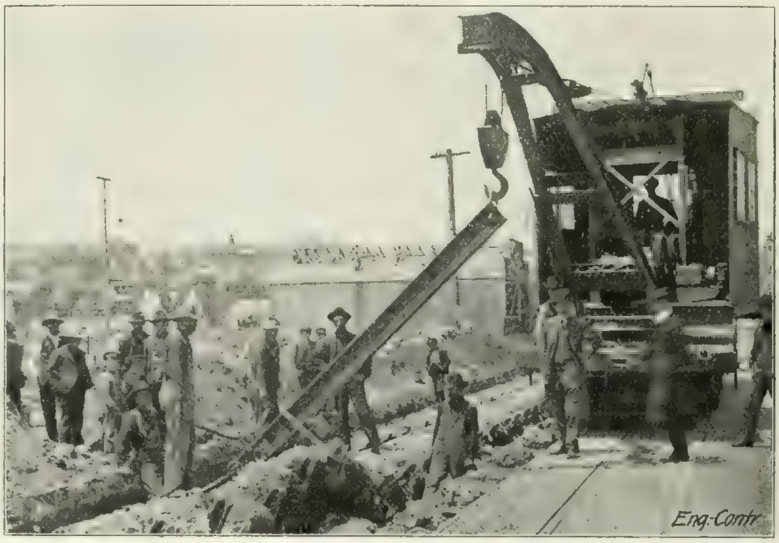


Fig. 1—Derrick Car with Lever for Removing Cable Track Yokes.

The gang necessary to operate the derrick car in pulling yokes consisted of two men on the car and three or four on the street. This gang working 10 hours, would break out from 200 to 500 yokes, depending upon the toughness of the concrete and other conditions rendering the work easy or difficult.

The concrete came out in lumps varying in size from 1 cu. ft. to ½ cu. yd. These lumps were broken up into 8 or 9-in. pieces with steel gads and sledge hammers. Three men worked together, one holding the gad with tongs and two striking with sledges. In these smaller pieces the concrete was ready for the crusher.

Figure 2 shows the crusher outfit. The crusher was set on one end of a flat car and was driven by belt from a motor set on the opposite end. A flexible trolley had current from the trolley wire to the motor. The crusher car was run over the track after the cross-ties and new rails had been laid, but before the track had been lined up. The crusher discharged directly between the rails, the car being moved along a few feet at a time to distribute the ballast along the track. Five or six men could break up the concrete and feed the crusher to its full capacity. The crushed concrete made an excellent ballast; it compacted very solidly, particularly after being wetted down with a hose.

No figures of cost are available for this work, but Mr. B. P. Legare, Engineer Maintenance of Way and Construction, informs us that a material saving was effected. The carting away of the old concrete was saved and the handling was reduced by depositing the ballast directly in place in the track. Wages were high, they being $2.50 per 8-hour day for the most ignorant class of Greek and Hungarian laborers.

Method and Cost of Constructing and Erecting Reinforced Concrete Poles.

The possibilities for reinforced concrete poles in transmission line work have recently been very carefully investigated by the Richmond (Ind.) Home Telephone Co., which has constructed a line across the Whitewater river, using poles ranging from 45 to 55 ft. in height of the construction shown by Fig. 1, invented by Mr. Wm. M. Bailey, Vice-President and General Manager of the company. The following account of these investigations and of the studies made by the American Concrete Pole Co., Richmond, Ind., which has been organized to market the poles, has been compiled from information given us by Mr. Bailey.

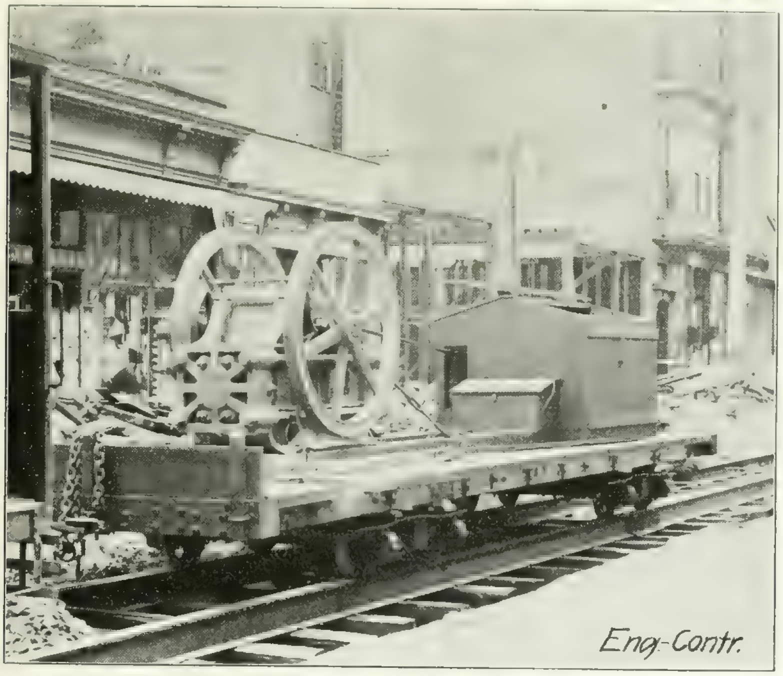


Fig. 2—Traveling Crusher Plant for Crushing Ballast.

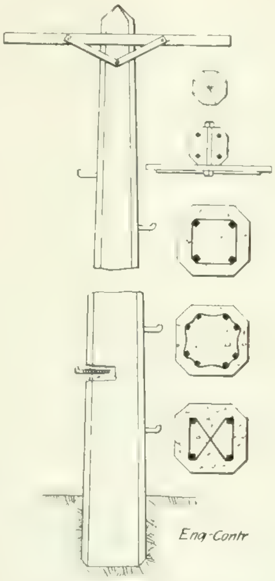


Fig. 1—Reinforced Concrete Telephone Pole, Richmond, Ind.

For poles 30 ft. long and under, the molding is done horizontally on the ground and the pole erected when hard like a wooden pole; for poles over 30 ft. long the molding is done in forms set vertical in the pole hole. The following figures, Table I, are given as the cost without royalty of concrete poles molded as described. These costs are for poles erected excluding the material cost of steps but including labor cost of setting steps, and they are based on the following wages and prices:

Foreman, per day	$3.00
Laborers, per day	1.75
Cement per barrel	2.00
Stone, gravel or sand, per cu. yd.	1.00

For sake of comparison, the cost of cedar poles has been added to the table; these costs include poles, unloading, dressing, gaining, roofing, boring, hauling and setting. All figures are as furnished by Mr. Bailey. Regarding the methods of constructing concrete poles, Mr. Bailey says:

"All of the larger concrete poles (that is, poles over 30 ft. in height), are built upright in position ready for use, the forms being set perpendicularly over the hole in which the pole is to be placed, the hole having been dug to conform with the size pole prior to the setting of form; thus when the concrete is poured in at the top of form, the hole is entirely filled and the concrete knit firmly to the solid earth that has never been disturbed. There is no replacing of earth or tamping required.

"All poles under 30 ft. in height, up to the present time, have been built on the ground and set after they have been seasoned, although there is some doubt in my mind and I believe that with the proper equipment and a little practice that it will be discovered that even the smaller poles can be built more economically upright. As to the cost of setting these poles, it is true that they will have to be handled with a derrick or gin pole, but with this equipment they can be handled very rapidly, and, I believe, almost as cheaply as the wooden pole. One can readily see that as the larger poles are built upright in position which they are to occupy, that there is no heavy material to handle—consequently, there will be no necessity for any heavy rigging or equipment. The hole is first dug and the form is set directly over the same. After the form has been placed, the reinforcing rods and binding wires are placed and the form is then ready to receive concrete. After the concrete has been poured in, it is left for about three or four days, depending on the weather, before the forms are removed. The most economical way of handling concrete is with a small mixer, capable of mixing 2 or 3 cu. yds. per hour and the old-fashioned grain elevator. With this equipment, the concrete is placed as rapidly as it is mixed and with the same power. The pouring in of the concrete into the top of the form tamps it thoroughly and it shows a solid compact concrete.

"This proposition is like a great many others—at first sight it appears impractical on account of first cost, but on investigation we find that this is only a phantom and that after all is done and said, the proposition is economy.

"I give you here the exact cost data on one of the 55-ft. poles erected over the Whitewater river at Richmond, Ind.:

Materials.

4 1-in. steel rods 40-ft. long, and 4 ¾-in. steel rods, 15-ft. long, including "U" bolts with which they were tied together	$13.34
56 cu. ft. of concrete	7.84
1 set of binding wires	1.80
Total materials	$22.98

Labor.

4 men setting form, placing rods, and binding wire, guying, truing same ready for concrete, one day:		
1 man at	$3.00	$3.00
1 man at	2.50	2.50
2 men at	2.00	4.00
4 men and one horse mixing and placing concrete, 2 hrs and 11 minutes		2.28
2 men taking down form and touching up pole, 3 hrs.		1.35
Total labor		$13.13
Total materials and labor		$30.11

"You will note that this cost is $4.18 in excess of my tabulated statement (Table I). This was due to the location of the lead. These poles were set in over rough ground and in a river bottom where we had water to contend with and the conditions were very unfavorable to the erection of any kind of poles. It would have cost considerable more to set wood poles in the same place. We were also obliged to use labor inexperienced on this class of work. I believe that after the men are properly broken in and equipment working properly, that concrete poles can actually be built for less than first class cedar complete, set in the ground. There is no comparison between wood and concrete when we take into consideration strength, durability, and its lack of destruction from other causes, such as birds, insects, lightning, etc. The more thought and test that the writer applies to this method of construction, the more enthusiastic he has become and he expects to see the day when no first class construction will consider anything but steel, iron or concrete poles."

TABLE I.—COMPARATIVE COST OF REINFORCED CONCRETE AND CEDAR POLES.

Concrete Poles.										Cedar Poles.			
											Cost.		
Length ft	Top. ins	Bottom ins	Size Steel, ins.	Cu. ft. conc	Cost of steel. $	Cost of concr't $	Cost of bind. W $	Labor. $	Total cost. $	Top. ins.	f. o. b. cars. $	Labor $	Total. $
25	6	10	1/4	16	1.57½	2.24	1.20	1.70	6.71½	7	2.60	1.50	4.10
30	6	11	3/8	21	2.29	2.94	1.20	2.20	8.63	7	6.25	2.00	8.25
35	6	12	1/2	26	3.91½	3.64	1.20	2.70	11.45½	7	8.75	2.40	11.15
40	7	15	5/8	36	6.31	5.04	1.50	4.20	17.05	8	12.00	3.50	15.50
45	7	16	3/4	43	8.56	6.02	1.50	5.70	21.78	8	17.20	5.00	22.20
50	7	17	7/8	50	9.50	7.00	1.80	7.20	25.50	8	20.20	6.50	26.70
55	7	18	1	56	13.34	7.84	1.80	8.95	31.93	8	24.80	8.50	33.30
60	7	19	1	61	14.56	8.54	1.80	11.70	36.60	8	29.75	10.00	39.75

The construction of a meter gage railroad around the falls and series of rapids extending fully 250 miles from the headwaters of the Madeira River in Brazil, is proposed by the Madeira-Mamose Co., recently incorporated under the laws of the State of Maine. The syndicate, in which Percival Farquhar, of York, Pa., is interested, will construct fully 2,000 miles of new lines, which will permit of intercommunication between Paraguay, Bolivia and Brazil, and will construct harbor improvements at Brazilian ports, which alone will entail a cost of $25,000,000.

Cost of Constructing Street Railway Track with Rubble Concrete Base at Ft. Wayne, Ind.

The track was single track in paved street, with sidings and turnouts, and the work consisted in excavating some 8 ft. wide and from 1 to 3½ ft. deep, placing the concrete, laying track, and repaving. The construction is shown by Fig. 1. The costs as given by Mr. H. L. Weber, chief engineer, Ft. Wayne & Wabash Valley Traction Co., were as follows:

There were 5,022 lin. ft. of single track made up as follows:

Main line, lin. ft.	4,481
Sidings, lin. ft.	476
Two left-hand turnouts, lin. ft.	65
Total track	5,022

There were 3,970 sq. yds. of repaving made up as follows:

In gage of main track, sq. yds.	3,399.1
On sidings, sq. yds.	453.9
1-ft. strip outside of rails, sq. yds.	1,117.0
Total paving, sq. yds.	3,970.0

The excavation consisted of a trench some 8 ft. wide and from 1 to 3½ ft. deep.

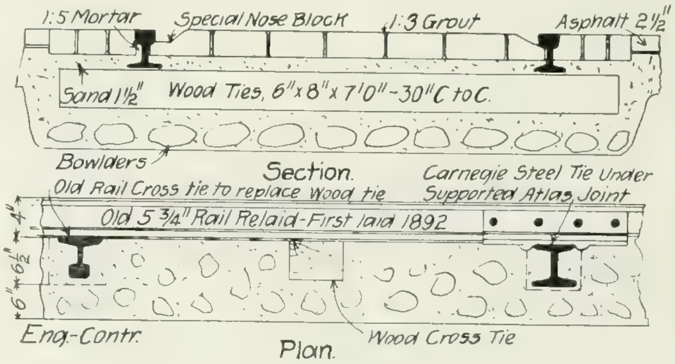

1:5 Mortar
Special Nose Block
1:3 Grout
Asphalt 2½"
Sand 1½"
Wood Ties, 6"x8"x7'0"-30" C to C.
Bowlders
Section.
Carnegie Steel Tie Under Supported Atlas Joint
Old Rail Cross tie to replace Wood tie
Old 5 ¾" Rail Relaid-First laid 1892
4"
6½"
6"
Eng.-Contr.
Plan.
Wood Cross Tie

Fig. 1—Street Railway Track with Rubble Concrete Foundation.

All excavated material was hauled away, teams costing 40 cts. per hour and common labor 16½ cts. per hour. The cost of excavation was as follows:

Excavating and hauling away	$3,378.03
1 new road plow	25.00
Total cost	$3,403.03

This gives a cost for excavation of 67.7 cts. per lin. ft. of track.

The track was laid with old 5¾-in. rails, which were reversed end for end. The ties were spaced 30 ins. on centers. Altogether 4,957 ft. of track were laid, costing as follows:

Item.	Total	Per Lin. Ft.
Labor	$784.81	$0.158
Ties	1,204.80	0.242
18 kegs spikes at $5.	90.00	0.018
8 kegs bolts at $5.85.	46.85	0.009
350 bonds at 60 cts.	210.00	0.041
Totals	$2,336.46	$0.468

The concrete work comprised the making and laying of 1,260 cu. yds. of concrete at the following cost:

Item.	Total	Per Cu. Yd.
Stone at $1.25 per cu. yd.	$973.55	$0.772
688 cu. yds. gravel and sand at $1	688.00	0.546
759½ bbls. cement at $2	1,519.00	1.205
Labor	527.68	0.418
Totals	$3,708.23	$2.941

This low cost of concrete per cubic yard was made possible by the use of cobble stones from the old cobble pavement in the concrete. It was estimated by the engineer that had broken stone concrete been used throughout the cost would have been $5.50 per cu. yd., so that a saving of nearly one-half was effected by using the rubble concrete. The cost of the concrete per lineal foot of track was $3,708.23 ÷ 4,957 ft. = 74.8 cts.

There were 3,970 sq. yds. of repaving which cost as follows:

Item.	Total.	Per Sq. Yd.
Gravel and sand	$344.20	$0.086
90½ bbls. cement at $2	181.00	0.046
33,145 new brick at $22.50 per M.	746.86	0.188
123,618 blocks at $18.25 per M.	2,256.86	0.568
Unloading and hauling brick	250.00	0.063
1 road roller	200.00	0.050
Labor	425.70	0.107
Totals	$4,404.62	$1.108

The cost of paving per lineal foot of track was 88.8 cts. and the total cost of the work per lineal foot of track was:

Excavation	$0.677
Track laying	0.468
Concrete	0.748
Paving	0.888
Total	$2.781

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Methods of Thawing Explosives.

We abstract the following from a paper by Mr. P. N. Dennison, of the Du Pont Powder Company, read before the Ohio State Stone Club.

During the year ending June 30, 1906, we find the item "thawing dynamite" second in the list of accidents occurring in the use of explosives. Sixty-six accidents due to thawing with thirty-two fatalities occurred, and I venture to say nine-tenths of them could have been prevented had proper care been exercised in the thawing. The figures for 1907 are not at hand, as I had but few days' notice to prepare this paper. I have not a doubt but that they will equal those of 1906, at least.

Many foreign countries have stringent laws on thawing and the use of explosives, the statistics showing a corresponding decrease in the number of accidents therefrom.

Note the following table taken from the British Government report. It covers all accidents from thawing from the year 1872 to Dec. 31, 1905. Every method mentioned is contrary to law in England:

1	Heating over fire	38
2	Reheating water in which dynamite had been previously placed to thaw	11
3	Placing the explosives in water, then heating that over a fire	10
4	Placing the dynamite cartridges in ovens	8
5	Thawing cartridges in the hands over a lighted lamp or candle	7
6	Placing dynamite in hot ashes	7
7	Warming on a shovel over a fire	5
8	Placing cartridges on top of heated stone	5
9	On a hot iron	4
10	On a steam pipe	2
11	Rubbing cartridges together to warm them by friction	1

Our record shows nearly as many accidents in twelve months as England had in thirty-four years.

During the six years ending Jan. 1, 1906, the United Kingdom had only nineteen accidents due to thawing, which shows that, following the right methods, whether forced by law or on our own account, is the only way to bring the accident list down to the minimum.

First, frozen dynamite is a dangerous article to handle. The nitro-glycerin is crystallized. Opening the end of a cartridge, you see the bright little specks that look like mica, and these crystals are sensitive to friction.

In the United States from July 1, 1905, to June 30, 1906, five accidents were reported from "breaking cartridges in two." A man was killed at Bellevue, Del., by breaking a frozen cartridge of 60 per cent N. G. powder in his hands. This practice is prohibited by law in Austria.

A blaster in this state (Ohio) was killed by tamping improperly thawed gelatin dynamite with a wooden bar. He was tamping the first couple of sticks when it exploded and blew the tamping bar through his body.

At Mitchell, Ind., last winter a man was killed when attempting to open a box of frozen dynamite with an ax or pick. Ordinarily, however, frozen dynamite is hard to detonate; in no case do you get its full strength, and when but chilled a great per cent of its strength is lost. Therefore it is necessary to thaw this explosive, and now we come to the actual work in preparing for a shot in cold weather.

I could add as many don'ts as there are troubles in the stone business, but a few will suffice.

To begin with, don't see your dynamite boxes slammed open with a pick or dropped into the quarry from a convenient ledge—just because it is "easier." Use a wooden wedge and a wooden mallet.

In thawing, a steady, dry and moderate heat is best. Too great a heat is apt to induce a chemical change in the dynamite which will make it extremely sensitive, besides the danger of leaking N. G.

Don't thaw the cartridge in hot water. I find this a common but very poor practice. It injures the explosive power by killing the effect which should be had from the soda ingredient, the paraffine coating is washed away, and, N. G. being heavier than water, there is always the chance for a remaining puddle of "soup," as the safe experts call it, to cause an accident. Also the water-soaked cartridges present an easier target for Jack Frost than those thawed in a dry atmosphere.

To thaw by throwing live steam against dynamite presents nearly the same problem as that of hot water.

Don't thaw over live steam pipes, on hot iron, around an open fire or on the boiler. The last named "don't" claimed a victim last winter at a Kalida, O., quarry. Dynamite thawing on top of the boiler exploded and killed the engineer.

There are many more "don'ts," but if you adhere strictly to the "do's" you won't need to bother about the don'ts. I mentioned those I know to be most prevalent.

For thawing large quantities of dynamite, a thawhouse heated by hot water pipes, the radiators being at the back or sides of the building and protected by a wooden partition, is by far the safest method. If it is arranged that the cartridges may be laid out on grooved shelves, each stick by itself, so much the better, for each will then obtain a uniform and regular heat and insure best results.

If steam pipes be used, the outlet should be left free and wide open, as there should be no pressure, and a valve should be placed on the pipe leading into the thawhouse, never at the outlet. Several explosions of thawing houses overheated by steam pipes have been recorded.

Another word about a thawhouse. I would recommend its being constructed so that a man could not get in on the explosive side at all, the door to open directly on the dynamite shelves. A door in the rear would enable a man to make necessary repairs on the radiators. This for the reason that many accidents have occurred due to the blaster stopping in a nice warm thawinghouse to insert his caps or make up primers.

You will doubtless remember the explosion at Port Clinton a year or so ago, wherein two men lost their lives. They were both in the thawinghouse, but about all that is known is that they started to run from the house shouting fire, when the building went up. This was probably occasioned by their accidentally setting fire to loose papers. The method of heating employed was a small stove set up on a box. Hot water heaters with no room for the men to loaf would have prevented this accident.

A stove in the middle of the room may bring trouble. One case in Pennsylvania and one in Kansas are recorded where thawinghouses heated by this method exploded. Both went up in the night when no one was near.

For small quantities there are several safe methods of thawing, just as easy and no more expensive than some of the dangerous methods now in vogue, and I cannot see why they are not generally used.

For instance, a man will take a bucket, fill it with dynamite cartridges and pour hot water over them. When they are good and slushy he takes this mush out, pours it in the drill-holes, gets a bad shot, and either jumps all over the dynamite or explains it by saying his stone is changing and the bottom is harder to shoot. Why can't he take the bucket filled with dynamite, then loosen up and buy a larger bucket to hold the water? Place the smaller bucket within the larger and cover with rags or anything to hold the heat. There you have a perfectly safe thawer, your dynamite is in the best of shape, and you save much of its explosive force. It can be carried to the shot and loaded direct, thereby minimizing the chances of being chilled.

There are thawing-kettles on the market, built on much the same plan, which can be purchased from any explosive manufacturer.

For somewhat larger quantities, use a barrel for the hot water and a milk can for the dynamite.

Manure makes a good thawer where the quarry is so situated that a supply can be kept up. The thawinghouse should be covered to a depth of 2 ft., which will generate a good heat. Authorities differ on the length of time manure will hold its heat-giving qualities. Some say two or three weeks, while others claim the same manure covering will give out heat all winter long. The contractors on the New York subway work used this method generally, burying a box sufficient to hold three or four cases of dynamite, in manure, then dug it out when needed. Opinion there seemed to give manure a life of two or three weeks only.

Another point to be considered is handling explosives when taken from the thawer; I have seen dynamite in excellent condition taken from the thawinghouse, placed in a cart and carried with no protection against zero weather for a half mile or more to the drill holes. This dynamite was undoubtedly chilled and a good percentage of explosive force totally lost before the blast.

If thawing-kettles are used it is best, as I have mentioned, to carry them direct to the shot.

In large quantities where you have a stationary thawinghouse, protect the dynamite on the way to the shot by, say, a burlap covering, or provide a box wherein it may be placed and covered up when hauled to the blast.

In other words, once thawed, keep your dynamite from all possible chance of exposure and get your shot off as quickly as loaded.

One more word in connection with cold weather shooting.

I wish to urge upon you the use of double strength exploders and quintuple caps in making the blast. The smallest item of shooting expense but one of the most important.

The dynamite cartridge you hold in your hand will give you no work until it is turned into gas—and the change must be instantaneous. To do this a detonator is used.

At the great testing stations it has been demonstrated by what we term the mortar test that a known load of dynamite exploded by means of a triple-strength cap will throw a ball a certain distance. The compounds have been turned into gas.

Now taking the same load and detonating with a quintuple cap is shown to throw a ball a farther distance. Just that much more gas has been generated instantly by stronger detonation.

By ballastic tests we find that dynamite, when chilled but not frozen, will not generate by 20 or 30 per cent the explosive force obtained from dynamite in perfect condition.

In a summing-up of this question it brings the thought that you have long needed a non-freezing powder, and I may say that a long and careful scientific research has but recently resulted in the perfection of a non-freezing explosive, especially designed to meet your requirements insofar as it is chemically and physically possible to do so.

However, 35 per cent strength is the maximum explosive force yet attained, but indications from our laboratories point to even greater results in the line of absolutely non-freezing explosives.

What I personally consider to be the most practical explosive for use in this particular territory, principally of limestone quarries, is the low-freezing grades of dynamite. This calls for no special detonators or extra trouble, and is, without doubt, one of the best things on the explosive market today. In strength it corresponds to the well-known grades of Hercules dynamite.

It will not freeze until the thermometer reaches 30 degrees F., two degrees below water-freezing point. That is the resistance to cold weather claimed at present; it will not freeze above 30 degrees F., but I have records where this powder was used in weather much below 30 degrees, and it was not frozen.

The Cost of Excavating Trenches by Hand for Electrical Conduits in Baltimore, Md.

Through the kindness of Mr. Chas. E. Phelps, Jr., chief engineer of the electrical commission of Baltimore, Md., we are able to give the cost of the trench excavation in building the conduit system of that city. Mr. Phelps has been chief engineer since the organization of this commission in 1898, and has planned and built all of the electrical conduits. All work has been done by day labor. Up to the end of 1905 there had been laid nearly 6,000,000 duct feet of conduit, mostly terra cotta, encased with concrete.

The figures we give show the cost of excavation from the inception of the work until June, 1907, a period of nearly nine years. The cost includes all the labor, both men and teams, timbering drainage, clearing away of obstruction, such as old pipes, etc., and back filling, but does not include paving. The wages paid to men and teams are shown in Table I, an 8-hour day being worked:

TABLE I.—SHOWING WAGES PAID LABOR PER EIGHT-HOUR DAY.

	Hr. rate foreman.	Hr. rate gang boss.	Hr. rate 2-horse teams.	Hr. rate laborers.
1899	$0 37½	$0 31¼	*	$0 20⅝
1900	37½	31¼	$0 37½	.20⅝
1901	37½	31¼	.37½ 40⅝	.20⅝
1902	37½	31¼	40⅝	.20⅝
1903	37½ 43¾	.31¼	.40⅝ .45⅝	.20⅝
1904	43¾	.31¼	45⅝	20⅝
1905	.43¾	31¼	.45⅝	.20⅝
1906	43¾	.31¼	.50	.20⅝
1907	43¾	.31¼	50	.20⅝

* One-horse cart used, paid 31¼ cts. per hour.

The cost of the work for each month is listed in Table II, showing the cubic yards moved, the aggregate cost, and the cost per cubic yard:

TABLE II.—SHOWING CUBIC YARDS EXCAVATED, TOTAL COST, AND COST PER CUBIC YARD FOR TRENCH EXCAVATION FOR ELECTRICAL CONDUITS.

Month.	1899.			1900			1901.			1902.			1903.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
		$	$		$	$		$	$		$	$		$	$
January...															
February.															
March.....															
April......	3060	4163.28	1.36							568	760.75	1.34	982	1821 96	1.85
May.....	3812	10965.50	2 88	2263	3337.89	1.48	2501	5304 89	2 12	595	856.76	1.44	1264	2040 86	1.61
June.....	3400	9823 99	2 88	2984	5175 30	1 74	1599	2321.09	1.46	1375	2531 95	1.84	1219	2782.16	2.28
July.....	3188	11910 81	3 73	2632	4324.21	1.64	1276	1564.51	1.22	924	1864 90	2 02	1789	3735.27	2.09
August....	4773	12347.15	2.60	952	2721.67	2.81	1089	1923 47	1.80	1401	2018.79	1 44	1438	3064 51	2.13
September.	3343	8063.66	2.41	825	2053.95	2.50	533	1270.66	2.30	911	1926.74	2.11	1538	2628.06	1.73
October.	3480	8723.16	2 46	1482	2069.03	1.40	60	771.65	12.84	785	967.67	2 50	1620	3720.44	2.30
November.	3317	7559 05	2.28	521	2140 85	4.10							1452	2177.62	1 50
December..	2723	8004.46	3.00	202	319 16	1.58	76	348.42	4.54				284	527.05	1.85
		$			$			$			$			$	
Totals.....	31097	81161.46		11862	22141.66		7155	13504 69		6559	11927 56		11590	22497.73	
Average each year.			$ 2 61			$ 1.87			$ 1 88			$ 1 82			$ 1 94

Month.	1904			1905			1906.			1907		
	1	2	3	1	2	3	1	2	3	1	2	3
		$	$		$	$		$	$		$	$
January...							1460	3624.54	2.48	235	523.43	2.22
February.							201	242.10	1.26	214	452.29	2.12
March.....							793	865.32	1.09	1215	1672 22	1.38
April......				1468	4324.55	2.95	2900	3017 90	1.04	1809	2632 03	1.45
May.....				2568	4210 08	1.64	1404	2252.22	1.61	1157	1481.63	1.28
June.....				2768	3847.62	1 45	630	966.43	1.54	1054	1714.65	1.62
July.....	14½	465 24	32 0	1406	2610.81	1.85	969	1535.57	1.58			
August....	592	766 96	1.30	1210	2426.44	2 00	319	641.79	2.01			
September.	302	462 45	1 53	880	1097 94	1 25	480	678 27	1 41			
October.	811	1388.73	1.71	1640	2160.63	1.32	465	917 99	1 98			
November.				2182	2618.78	1.20	341	518.00	1.61			
December..				1353	2270.26	1.70	22	66 69				
		$			$			$			$	
Totals.....	1720	3083 38		15476	25567 08		9984	15326 52		5687	8477 25	
Average each year.			$ 1.97			$ 1 65			$ 1.53			$ 1 49

1.—Number cubic yards excavated. 2.—Total cost of excavation. 3.—Cost per cubic yard.

The excavation work was entirely in earth, which was sand, clay, the debris of filled in ground, and black mud on the streets near the harbor. The trunk lines of the conduits are mostly in the streets or alleys, but many of the distributing ducts are laid under the side walks, and frequently on both sides of the street. In the low sections of the city many of the trenches had to be underdrained. These ditches needed shoring, likewise those dug through sand. But little timbering was done through the other materials, especially for the distributing ducts, which were uniformly about 3 ft. deep and 2 ft. wide, making about ¼ cu. yd. of excavation per lineal foot of trench, including the excavation for service and distribution boxes, which are from 60 to 70 ft. apart.

The trenches for the trunk lines are from 3 to 12 ft. deep, being on an average of 6 ft. and varying from 2 to 4 ft. in width, or an average of 3 ft. This means an average of 2-3 cu. yd. of excavation per lineal foot of trench, exclusive of man-holes. These are so far apart, that the extra excavation will increase the average but little.

The per cent. of labor of the total cost varied somewhat for each year, running as low as 81 per cent for the main trunk lines, where much shoring had to be done, and the trenches were wet, up to 97 per cent., where little shoring was needed, averaging 95 per cent. For the distributing lines the per cent. of labor of the total cost of excavation averaged 97 per cent, varying from 94 per cent to 98 per cent. These percentages include labor, both men and teams.

It will be noticed that the price paid for teams and also for foremen has increased, yet, with the exception of the year 1903, the cost of excavation has steadily decreased. This, too, in spite of the fact that the amount excavated has decreased. This is due primarily to the work every year being farther and farther from the center of the city. In the central district of the city, the excavation is more difficult, owing to the pipes, sewers and other obstructions being larger and more numerous.

The high price per cubic yard of $32.02, for July, 1904, was especial emergency work, as a result of the great fire that occurred in Baltimore, in February, 1904, when a large section of the business part of the city was destroyed. This price bears no relation to the general work, but is included to complete the record.

The cost of excavation also includes the cost of watching, this item being large, on account of the short working day, and the fact that two 8-hour shifts must be made of the watching. This doubles the cost of this item.

Two horse dump wagons are used for hauling the excess material away from the trench. These wagons are of a nominal capacity of 2 cu. yds., but the average load is about 1½ cu. yds. place measurement. Each team averages five trips to the dump per day, thus hauling 7½ cu. yds.

The output of gold from the Transvaal in 1907, according to the London Journal, South Africa aggregated $133,360,292, against $119,618,507 in 1906, and $61,265,575 in 1903.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Meaning of the Expression "Approximate Estimate" in Specifications.*

BY ALEXANDER POTTER, C. E.†

Misunderstandings and troubles, have frequently arisen between engineers and contractors over the meaning of the term "approximate estimate," and a considerable number of law suits have resulted in which the exact meaning and use of this term have played an important if not a controlling part.

According to the standard dictionaries, the words "approximate" or "approximately" seem to be clearly defined as something "close to in equality, degree, or quantity;" as something "nearly but not exactly accurate; as an approximate estimate; an approximate result;" as "very nearly but not absolutely."

In engineering work when the quantity and character of the work cannot be absolutely and definitely determined beforehand, and competitive bids are required, the standard of comparisons must be an approximate one. Bidders are invited to name prices per unit of measure, the quantities being given approximately only, to enable the contractor to determine at what price he will undertake a job of the size estimated, and it is customary to state in the invitation to bidders that the quantities named are approximate only. Now out of the different understandings of the meanings of this term "approximately only" have arisen the many disputes regarding claims for extra work, questions of fraud and misrepresentation on the part of the engineer, the interpretation of contracts in general, and of what constitutes balanced and unbalanced bids.

As the engineer is usually made the final arbiter of all questions arising under a construction contract, with power to make alterations, additions or omissions, and to determine the value thereof, the engineer's understanding of the meaning of the words "approximate estimate" becomes of the utmost importance, and some general rule should be adopted defining its meaning. Unless in engineering practice there is some well established rule to the contrary, the meaning of the work "approximate" must apply in engineering contracts and specifications which we find given in the dictionaries, i. e., that the engineer's estimates are "very nearly but not exactly accurate." The writer knows of no such rule in engineering as would warrant any other meaning being applied to this term in any of its connections.

We have already stated the purpose of an approximate estimate, viz.: to obtain balanced bids for comparison in order to ascertain the lowest bidder upon any given piece of work. Unless, therefore, a uniformity of understanding as to the meaning of the word approximate exists, opportunity is afforded for misunderstanding between the parties, which, while it may be honest, is none the less troublesome and may work great injustice.

In the first place, many contracts are let under an erroneous impression as to who is the lowest bidder. It is assumed in many cases that approximate estimates are set forth simply for the purpose of canvassing bids and that the low bid is properly that one in which the summation of the items, the approximate estimate multiplied by the unit prices, is less than all the others. This may or may not be true, and depends upon the accuracy of the approximate estimate. The truly lowest bid is that one in which the summation of items in the final estimate multiplied by the unit prices would have been the lowest. The necessity of accuracy and correctness in the approximate estimate is readily seen therefore. The main object in getting bids from contractors is not merely to determine who is lowest on the face of the returns but to ascertain who will complete the work for the least amount of money.

Many engineers in advertising public work specify certain quantities of work to be performed, but in the subsequent contract presented to the successful bidder for his signature carefully omit the quantities advertised as approximate so that they form no part of the contract. It needs no argument to set forth how unjust and unfair this may prove to be. The advertisement and proposal should always be made a part of the contract and specifications by specific reference thereto in the contract itself.

The powers and responsibilities conferred upon an engineer in connection with public work are often vastly greater than even the engineers themselves believe or realize to be the case. The importance of setting before the contractor proper and accurate data and estimates is one which the engineer must not consider lightly. If the engineer has any thought that the specifications and estimates do not represent or are not likely, such clauses should be inserted in the contract as will give the contractor the right to demand that for unreasonable discrepancies the work shall be paid for at cost plus a reasonable margin of profit. This may to a certain extent suggest an innovation in the manner of letting contracts, but I believe that it is the only fair and just thing to do and will in the end save not only trouble and litigation, but be a financial saving to the communities or companies adopting it.

---

*Paper read Feb. 12, 1908, before the Ohio Engineering Society, at Columbus, O.

†Consulting Engineer, 143 Liberty St., New York City.

Under the average specifications the engineer is not only a court of last resort and final arbitration, with powers of final decision specifically delegated to him, but he is also in reality the attorney for the defense, for the reason that he has either himself prepared all the important and vital clauses of the contract and specifications, or has inserted them from contracts which other engineers have previously prepared. It is customary for the legal representatives of the city or company letting the contract to have little to do with the preparation of technical contracts and specifications for construction work, merely passing upon the correctness of their legal form, and not at all upon their subject matter and requirements.

The engineer is also practically a defendant in matters of dispute arising between his employer and the contractor, because it is upon the correctness of his estimates that the work is based. On this account the tendency is very strong and the temptation very great for the engineer to endeavor to "make good" his estimates by minimizing as much as possible the difficulties met in the construction of the work by endeavoring to force the performance of work which had clearly never entered into the mind of the engineer or the contractor when the contract was signed. Had it been foreseen, the contractor would never have taken the contract under the conditions specified, and the engineer, had he known of such conditions being present, should have forewarned the contractor, or given notice of them in his approximate quantities.

The engineer, having assumed the high duties of judge, jury, defendant's attorney, and defendant in a court of last resort, should be a man of fearless justice, above suspicion or fear of himself, who will so write his specifications that he can with honor and fairness do right and justly by both the city or company who employs him and the contractor who pleads for justice in his court. Until the engineering profession will rise to this high standard and condition it can never hope to stand where its mighty works should place it, not only a peer of the other professions, but on the topmost pinnacle of them all. In none of them is there a higher or a more urgent call for fearlessness, justice, and fair dealing.

Contracts written with double or uncertain meanings, evasive clauses, or unjust and arbitrary assumptions of power, in the end bring no credit upon the engineer who writes them, nor profit to the corporation in whose favor they are enforced.

There are of course allowable and unavoidable variations in contracts and approximate estimates.

In the fabrication of steel, in the manufacture of machinery, and in the erection of the superstructures of buildings, there are but few and minor elements of chance which would interfere with a contractor giving such an intelligent bid that, provided his bid is a balanced bid, no harm can come either to the city or corporation or to himself by reason of a large discrepancy between the approximate estimate advertised and the amount of work which the contractor is called upon to actually perform, having only the fluctuation in the price of labor and materials. But in all work involving the uncertainties of excavation of any sort, whether it be in earth, quicksand, or rock, such as is encountered in the construction of reservoirs and dams, water works, sewers, railroads, canals, docks, or deep foundations, the actual cost of the work may differ very materially from what either the engineer or the contractor assumed the work would cost when the contract was entered into. The actual cost of removing earth and rock is in many cases from 50 to 200 per cent greater than the engineer deemed at the time to be fair unit prices for such work. In other cases the actual cost of performance of work has often proved to be from 50 to 75 per cent less than the prices bid upon the work, which price was based upon the best information at hand at the time the bid was prepared. Often, as the work advances, the actual conditions develop a state of things which prove that the information given in the first instance was entirely misleading. On this class of work, therefore, it is seen how important it is to have the approximate estimate of quantities approach the actual quantities which are to be required to be done as closely as possible, for if, on the one hand, the contractor has been led to believe that there is a certain amount of material to be handled and he is being greatly overpaid for the work performed, it is not fair to the city or corporation for whom the work is being done, that it should be compelled to pay such excessive prices upon an amount greatly in excess of the advertised quantities and on which the contractor estimated his profits. While, on the other hand, if the contractor has agreed to the performance of work at a price which is grossly inadequate, under the honest misapprehension of conditions, it is unfair, under the omnibus clause in the contract providing for variations, additions, and changes, to compel him to perform work greatly in excess of the quantities upon which he was willing to risk his judgment and his capital as to the value of the work.

The limiting of the words "approximate estimate" to mean a quantity within a reasonable percentage above or below the amounts called for, will tend to much more intelligent bidding, and also to the eradication and elimination of much of the trouble and litigation now occupying the courts of this country, due to the involuntary fraud upon or on the part of cities permitting or compelling contractors to perform work at absurdly high or absurdly low prices upon amounts which neither the engineer nor the contractor dreamed he would be called upon to perform at the time of the signing of the contract.

There should be no difficulty in inserting clauses in specifications providing that when the approximate estimate shall have been exceeded by a certain predetermined percentage, the unit prices bid upon the work shall no longer prevail, but that the balance of the work shall be performed at cost to the contractor plus a reasonable percentage for profit on labor and material.

Under the ordinary form of contract the engineer is now empowered to make any and such changes as he may see fit in the work. In other words, he is given such extraordinary powers of control over the contractor, that the contractor can harly object to having delegated to the engineer the determination of what this extra cost shall be; and the city or corporation having already placed in the hands of the engineer the responsibility of conducting its work, should have no objection to vesting him with this small additional power. The writer can conceive of no difficulties arising from such a restrictive clause as that mentioned, and believes that in the end the adjustment of all inequalities under the contract, and provisions for settling them, would tend to the lowering of the cost of contract work generally.

The question will of course arise as to what this limitation in the variation of each item over the approximate estimate should be. But this is not difficult to determine. Ideas will differ somewhat, but under the interpretation of the word as given in the dictionary, they can not differ to any great extent. In the writer's judgment there should not only be a limitation upon the gross amount of the contract, but also a limitation on each particular item of the estimate. The allowance of variance for any particular item would depend largely upon the factor of uncertainty involved and should of course be greater than upon the total amount of the contract. On a single item there might be conditions of variation of as much as 50 per cent, while on the total amount of the contract the variation allowed should doubtless never be more than 20 per cent without some readjustment of prices upon such a basis as that mentioned, viz.: that when the approximate estimate shall have been exceeded by a certain predetermined percentage, the unit prices bid upon the work shall no longer prevail, but that the balance of the work shall be performed at cost, plus a reasonable percentage of profit on labor and material.

Methods and Costs; Some Old, Some New.

Rolling Reservoir Embankment.—The earth on a reservoir embankment was spread in layers about 2¾ ins. thick and consolidated by means of a roller operated by electricity. Steam rollers could not be used owing to the difficulty of getting them to the work and the lack of available fuel. A waterpower nearby was easily developed so as to run a small generator which developed sufficient current for pumping and also for operating the roller. The latter weighed about 7,700 tons and had three grooved wheels 3¼ ft. in diameter, one in front used for steering and two behind on a single fixed axle. A large gear was attached to the axle and was driven by a worm on the extension of the armature arm of an 18 HP. motor. The current at a voltage of 250 was delivered by a pair of wires on which ran trolleys connected by flexible cables with the rollers. The speed of the roller was from 1 to 4 miles per hour, being controlled by means of a resistance box.

Tunnel Alignment.—Grade revision work on the Erie R. R. made necessary the construction of a tunnel 5,300 ft. long near Otisville, N. Y. Before commencing work the tunnel tangent was checked. The methods used in the alignment of this tunnel are described in a recent issue of The Polytechnic and the matter in this note has been taken from that article. As there was no point on the ground from which it was possible to see both ends of the tangent, a tower was erected, over the hub, on the highest point of the line. This tower consisted of a tripod, 25 ft. high, for the instrument, and an entirely separate platform for the transitman. The head of the tripod was arranged to allow liberal play from side to side and a wooden box was built under it to protect the plumb bob from the wind. The transit was first set up on the line as it was staked and was then brought into true line by interpolating between the extreme points of the tangent. As one of these points was 10,500 ft. distant, while the other was only 800 ft. distant, the backsight was taken on the more distant point and the transit was moved till it "split" the nearer rod. After the line had been proved by repeated checking, points were set on each side of the shaft and repeatedly checked to insure accuracy. These points were permanent, being concrete monuments, so set as to be free from action by frost. The transit was then set up over these monuments and three points were set on the top timbers of the shaft, two on the top and one on the inside face of each timber. These were protected by boxes built around them. Grooves were filed across the heads of the nails and set on line with the transit. The wires, by which the bobs were suspended in the shaft, were run through the grooves in the nail heads and were carefully checked for line. The action of the air in the shaft caused so much vibration of the wires that the bobs were allowed to hang in pails of thick "signal oil." Two methods were used to be sure the bobs hung free. The cage was run slowly up and down the shaft while a man carefully examined each wire; then a light was moved around the bobs while a man sighted down each wire. After ascertaining that the bobs hung free and that they were steadied by the pails of oil, the transit was set up, in approximate line some distance down the heading and was then brought into line with the two wires. In order to make the wires visible a piece of glass, painted over with a thin coat of white paint, was held back of the wires and an acetylene gas bicycle lamp was held back of this glass. This made visible only that part of the wire which passed in front of the glass. By holding the glass higher on one wire than on the other made both visible at the same time. Just enough light to enable the cross-hairs to be seen, was thrown on the object glass of the transit. When the transit was found to be on line by this method, a point was set in the roof of the heading on the opposite side of the shaft at an equal distance from it. This was done by setting a plumb-bob string, which was illuminated as before, on line and drilling a hole in the rock on the given point. In this hole a wooden peg, 1 in. in diameter by 4 ins. in length, was forced and in this peg was driven a horseshoe nail the head of which had been flattened and drilled. A plumb-bob was then hung from the hole in the nail and checked for line. The transit was then set-up in under this bob and back sighting on one of the wires the other wire was used as a check. The line was produced through the headings by the roof points set as already described.

Eight Hour Laws.—Thirty-six States and Territories of the United States now have eight-hour laws regarding the employment of labor. The following brief abstracts of these laws show the work to which they specifically apply:

Arkansas — Public highways and bridges.

California—Public works for State or political subdivision or, whether done by contract or otherwise.

Colorado—Workmen employed by State, county, municipality, etc., and to employes in mining operations.

Connecticut—Eight hours unless otherwise agreed.

Delaware—Municipal employes of Wilmington.

District of Columbia—For all employes of District or of contractor or subcontractor on public work for District.

Hawaii—Employes on public works.

Idaho—Laborers employed by day on all state, county and municipal works.

Illinois—All mechanical employments by day labor, and on public highways.

Indiana—All classes of mechanics, and laborers; over work by agreement and for extra compensation permitted.

Iowa—On public roads.

Kansas—Laborers or mechanics, or others employed by or on behalf of the state, county, city or township.

Kentucky—On public roads.

Maryland—No labor or mechanic employed by city of Baltimore or its agent or its contractor.

Massachusetts—Mechanics, laborers or workmen employed by or on behalf of state, or any county, city or town upon acceptance of statute at any general election.

Minnesota—Laborers, workmen or mechanics employed by or on behalf of state, whether work is done by contract or otherwise.

Missouri—Eight hours a legal day's work. On highways work day of eight hours is stipulated.

Montana—On public works, in underground mines and smelters.

Nebraska—On public roads and on all public works in cities of the first class.

Nevada—On public highways and in all works or undertakings carried on by state, county or municipal governments.

New Mexico—On public roads and highways.

New York—On highways and on work done by or for the state or municipal corporation, whether directly by contractors or sub-contractors.

Ohio—In any manufacturing, mechanical or mining business.

Oklahoma—On public roads.

Oregon—On public roads.

Pennsylvania—All classes of labor and service by the day where there is no agreement to the contrary. All laborers, mechanics and workmen in employ of state or municipality or otherwise engaged in public work. The act applies to employes of contractors.

Porto Rico—On public works.

South Dakota—On public highways.

Tennessee—On highways.

Texas—On highways.

Utah—On all works carried on or aided by the state, county or municipal governments.

Washington—On any work done for state, county or municipality.

West Virginia—All workmen, laborers or mechanics employed by or in behalf of the state.

Wisconsin—On public highways; and in mechanical or manufacturing business where there is no express contract to the contrary.

Wyoming—On all state and municipal works.

A Study of Roof Trusses.*

BY N. CLIFFORD RICKER.†

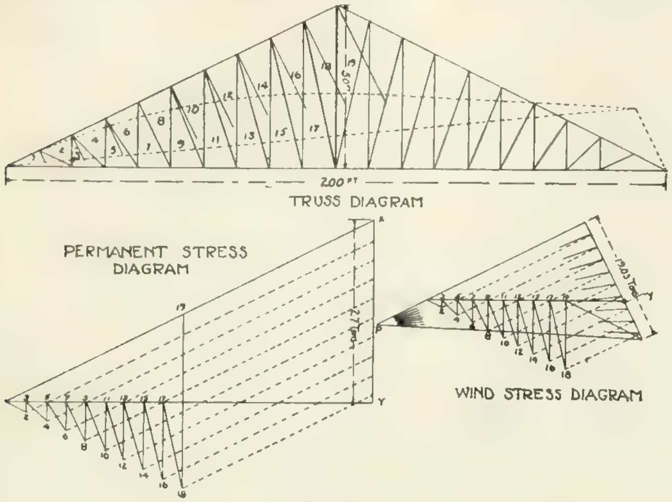


Fig. 1.

This investigation had for its original object the determination of a formula for the weight of roof trusses more accurate than those now in existence. As the investigation progressed, however, other topics arose and some interesting results were secured, which it is believed will be of value to architects and engineers. The chief result of the work has been the devising of a method to save time and labor by presenting data in a form most convenient for comparison. This system will be found convenient in calculating and designing roof trusses to satisfy given conditions, whether constructed of wood and steel or entirely of steel.

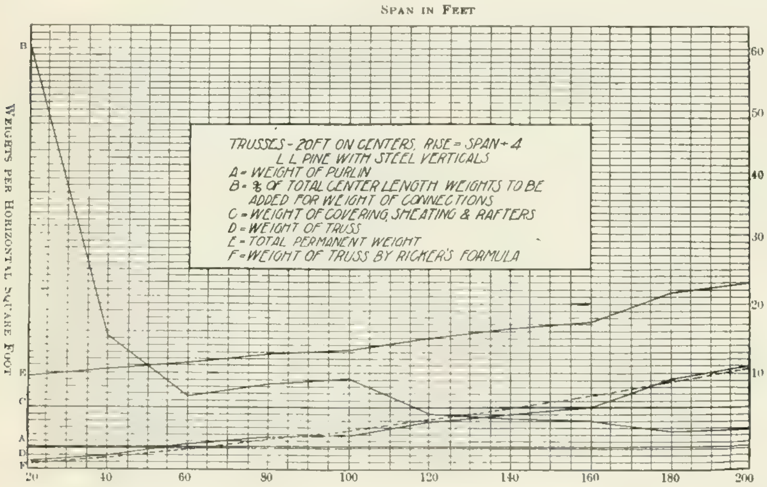


Fig. 2.

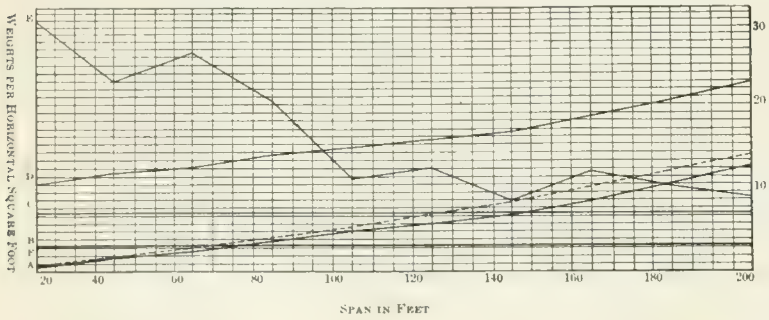


Fig. 3.

Method of Investigation.—In the determination of weights, general mathematical methods may be readily applied to most forms of bridge trusses, especially those with parallel chords; these are, however, less valuable for roof trusses where far more varied conditions must be arbitrarily limited in order to make such methods applicable. The results are then of doubtful worth. A more practical method of investigation was therefore chosen. For a single common type of truss, Fig. 1, nearly fifty trusses of varied span, rise and distance apart were calculated and designed in the same general way. Next the weight of each truss was carefully computed, and if this materially differed from the assumed weight of the truss, the necessary corrections were made in the sectional dimensions and weight of members.

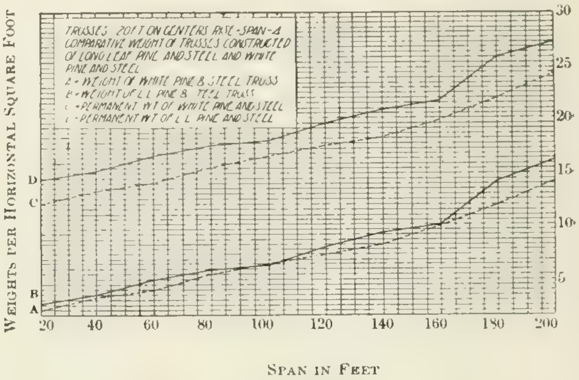


Fig. 4.

The verticals were steel rods with upset ends; all other members were long leaf pine timbers. Splices in the tie beam and its connection with the principal were made with vertical steel fish plates and through bolts. A purlin rested on each apex of the principal and supported the rafters on which was laid ⅞-in. matched sheathing covered by a painted tin roof.

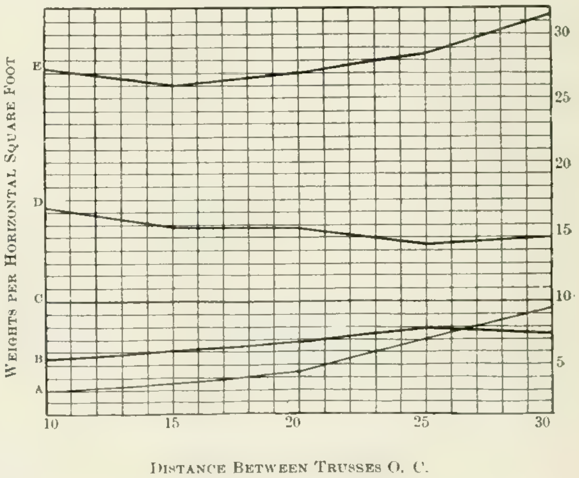


Fig. 5.

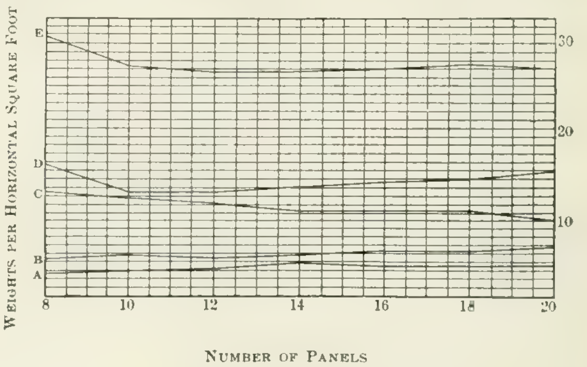


Fig. 6.

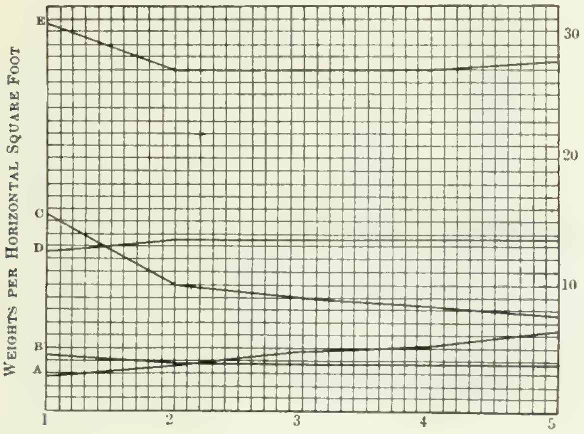
In accordance with the usual custom of engineers the roof was assumed to support a snow load and wind pressure at the same time, although the writer believes that this extreme condition rarely occurs. The assumption, however, provides some surplus strength for contingencies, such as unusual snowfall, very violent winds, etc.

---

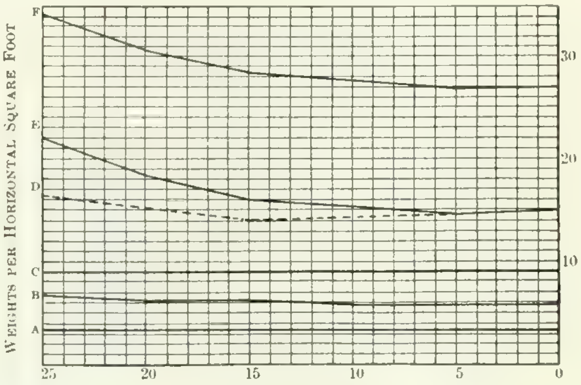
*Abstrated from Bulletin No. 16, University of Illinois Engineering Experiment Station.

†Professor of Architecture, University of Illinois, Urbana, Ill.

Conditions Assumed.—The spans of the trusses were assumed to vary by 20-ft. intervals from 20 to 200 ft. The rise of the trusses was varied by 5-ft. intervals from 1/10 to ¼ the span. The distance between trusses was varied by 5 ft. intervals from 10 to 30 ft. The horizontal panel length was varied from 10 to 25 ft. The number of purlins per panel was varied from 1 to 5.



Purlins per Panel.
Fig. 7.



Rise of Lower Chord
Fig. 8.

(1) *Permanent Loads.*—The following are the permanent loads assumed.

Painted tin covering, 2 lbs. per sq. ft.

Long leaf pine lumber, 4 lbs. per sq. ft. B. M.

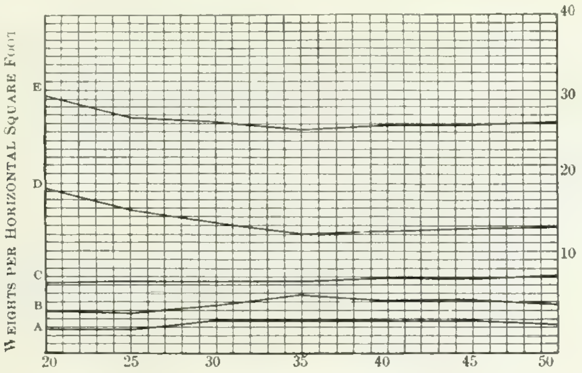
Steel (see Cambria, etc.), 480 lbs. per cu. ft.

Cast iron, 450 lbs. per cu. ft.

Weight of truss assumed.

The weights of trusses were first assumed in accordance with Merriman and Jacoby's formula, but the following formula was deduced from the results of this investigation and is found to agree more closely with the computed weights of the trusses examined:

$$W = \frac{S}{25} + \frac{S^2}{6,000},$$ in which S = span in feet and W = weight of truss in pounds per square foot of horizontal projection of the roof.



Rise of Truss in Feet
Fig. 9.

(2) *Snow Load.*—The snow load varies with latitude, but was here assumed at 20 lbs. per square foot of horizontal projection of roof for location of Chicago. Denoting by i the angle of inclination of roof surface with the horizontal, we have 20 cos i = snow load in pounds per square foot of inclined roof surface.

(3) *Wind Pressure Normal to Roof.*—The formula for the normal wind pressure most commonly employed in England and the United States is that of Hutton, viz.:

$$P_n = P \sin i \,(1.84 \cos i - 1)$$

in which P denotes the pressure on a vertical surface and P_n the normal pressure. A review of Hutton's apparatus and experiments (Hutton's mathematical papers) casts serious doubts upon the accuracy of this formula. The complex form is also objectionable. Other formulas are proposed by different authors. A comparison of these shows that different formulas give widely different results.

Müller of Breslau is the greatest living authority on graphic statics and probably on the theory of bridges and roofs; his formula, however, gives the smallest values for normal wind pressures. It is evident that very little is certainly known concerning the relation between horizontal and normal wind pressures; hence the following empirical formulas were here adopted as being sufficient and convenient in use:

Taking the angle i in degrees,

$P_n = \frac{2}{3} i$, for $P = 30$ lb. per sq. ft. horizontal pressure.

$P_n = 8/9\ i$, for $P = 40$ lb. per sq. ft. horizontal pressure.

$P_n = 10/9\ i$, for $P = 50$ lb. per sq. ft. horizontal pressure.

These formulas are applicable for values of i less than 45° for higher inclinations, the normal and horizontal pressures are equal. They were believed to be original, but it has since been found that similar formulas had already been published.

Weights of Trusses of Different Spans.—Ten trusses were designed for spans of 20, 40, 60, 80, 100, 120, 140, 160, 180 and 200 ft. respectively. The trusses were set 20 ft. apart with a uniform rise of ¼ span, the panel lengths being 10 ft. Their weights were computed and plotted in Fig. 2 and the points connected by the broken line *D*. The increasing slope of this line shows that the weight of the truss increases faster than the span. The total permanent weight of the roof also increases with the span. The additional weight of the connections, however, diminishes very rapidly for spans less than 60 ft. and varies irregularly for greater spans. Other weights are constant.

The following empirical formula for weights of long leaf pine and steel trusses is represented by the dotted line in Fig. 2, which agrees well with the computed line *D*

$$W = \frac{S}{25} + \frac{S^2}{6,000},$$ where S = span in feet and W = weight of truss in pounds per square foot of horizontal projection of roof.

Weight of White Pine and Steel Trusses.—A series of trusses constructed of white pine timbers and steel verticals was also designed and computed. The results of these computations are shown in Fig. 3. The preceding formula is represented by the dotted line *F*, which here gives weights somewhat exceeding those found by computation. In Fig. 4 is shown a comparison of the weights of trusses and also of the total weights of roofs constructed of the two kinds of wood. White pine makes a somewhat lighter truss and roof than long leaf pine. However, in designing, it will be most convenient and accurate to apply the same formula and make the necessary reductions on the stress sheet.

Weight of Steel Trusses.—Several steel trusses of different spans were also designed and computed. Their weights for spans of 100 and 200 ft. were found to be about the same as those of long leaf pine and steel trusses. Therefore the formula is also applicable to steel trusses. It is very probable, however, that for short spans, steel trusses are somewhat heavier than those of wood and steel given by the formula; their connections are far more complex and certainly require the addition of a larger per cent to the center length weights of truss. But these variations are taken into account on the stress sheet.

Most Economical Distance Between Trusses.—Trusses of 200-ft. span and 50-ft. rise spaced 10, 15, 20, 25 and 30 ft. apart respectively were designed and their weights were computed. The results are shown in Fig. 5. The weight of covering, sheathing and rafters remains constant; the weight of the purlins and connections increases, and the weight of the truss diminishes as the distance between the trusses increases, being a minimum for a spacing of 25 ft. The total weight of the roof, however, is a minimum when the trusses are 15 ft. apart.

Most Economical Size of Panels.—Trusses of 200-ft. span, 50-ft. rise, set 20 ft. apart, were divided into 8, 10, 12, 14, 16, 18 and 20 panels to determine the best length of panel. The results are given in Fig. 6 and show the following: (1) That the weight of covering, sheathing and rafters increases with the panel weight; (2) the weight of the purlins diminishes; (3) the weight of the truss and very nearly that of the entire roof is a minimum for a panel length of 20 ft. Therefore 20-ft. panels appear to be most economical.

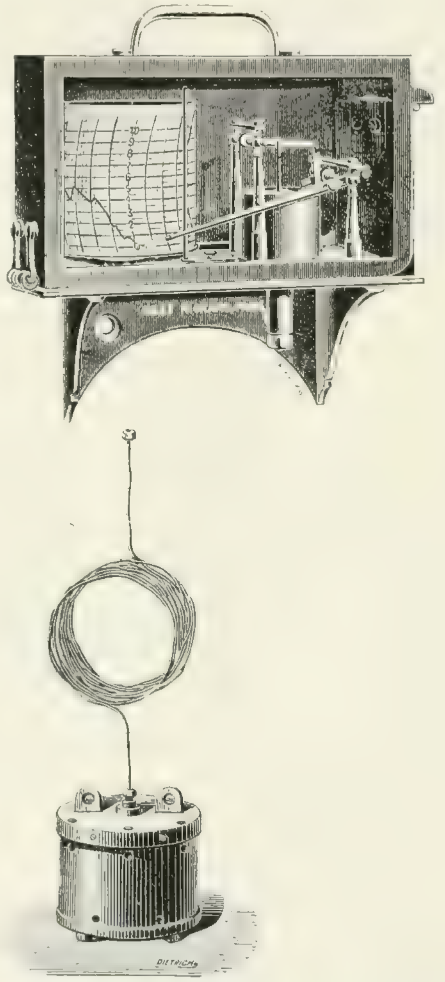
Best Number of Purlins per Panel.—For a series of trusses of like dimensions with panel lengths of 25 ft. from 1 to 5 purlins were used on each panel length of the principal, which was therefore required to resist safely the longitudinal compression and the stresses caused by the weights of the purlins and their loads. The results are plotted in Fig. 7. These show (1) that the weight of the purlins increases with their number; (2) the weight of covering, sheathing and rafters decreases; (3) the additional weight of the connections slightly diminishes; (4) the weight of truss is increased, but is least with one purlin per panel. The total weight of the roof is at least for 2, 3 or 4 purlins. No advantage results from the use of more than 2 purlins per panel of 25 ft. or of more than one for panels of ordinary size.

Effect of Raising Lower Chord at Center of Span.—Trusses of like dimensions were designed, excepting that the lower chord was raised 0, 5, 10, 15, 20 and 25 ft. respectively at the center of span, the rise of upper chord being 50 ft. The results are given in Fig. 8. The dotted line *D* represents the weights of trusses of equal depth at the center but having a horizontal lower chord and supporting smaller normal wind pressures on account of their lesser inclinations.

The weight of covering, sheathing, rafters and purlins remains constant; the weights of trusses and of roofs both increase rapidly with the rise of lower chord. A comparison of curves *D* and *E* shows clearly that this raising or cambering of the lower chord is not economical and is done only for effect.

Most Economical Ratio of Rise to Span of Truss.—A series of trusses of 200-ft. span and set 20 ft. apart was also designed and computed for rises of 20, 25, 30, 35, 40, 45 and 50 ft. respectively in order to determine the best proportion of rise to span. The results are plotted in Fig. 9. As the rise increases, the weights of covering, sheathing, rafters and purlins slightly increase; also the additional weight of the connections. The weight of trusses and that of the roof diminish, each being a minimum for a rise of 35 ft., which is practically one-sixth the span, identical with the ratio for ordinary bridge trusses. Hence the best rise is one-sixth the span.

A Recording Water Gage for Rivers, Reservoirs, Tanks, Boilers, Etc.



Automatic Recording Water Gage.

We illustrate herewith one of several types of automatic recording gages for registering the surface height of water. This particular gage may be mounted any distance within 300 ft. of the reservoir, tank or river. A small copper tube transmits the air pressure that actuates the lever upon which is mounted the recording pen. The cylindrical iron box from which this copper pipe leads contains a rubber bag to which the copper pipe is attached. The rubber bag is half full of dry air. The iron box contains a number of holes, so that when submerged in water the water presses directly upon the rubber bag of air. Any variation in the head of water produces a corresponding variation in pressure of the air within the bag, which is transmitted through the copper tube to the recorder. This device may be used for years without the slightest repair.

Other recording water gages are made by the same firm that makes the one just described, Ernest H. Du Vivier, 14 Church street, New York, among them being one that operates by electricity and transmits to a recorder placed at any desired distance from the water. Another is a simple device, consisting of a float and suitable cords and sheaves that operate the recording pen. Another is designed especially for recording the water level in steam boilers, thus securing a permanent record of the care and efficiency of the man in charge of the boiler. The catalog of the firm describes these various devices, some of which are probably new to many engineers.

The only fire alarms in use at Valparaiso, Chili, are a few large bells located in different sections that are tolled in such a way as to announce which company is desired by the use of the number of strokes given the bell in succession with different lengths of intermission. The city, which has 160,000 inhabitants, has 15 volunteer fire companies.

The Court of Appeals has handed down a decision upholding the constitutionality of the Bronx Valley (New York) sewer, which is to drain the territory from White Plains to West Mount Vernon, cross the lower section of Yonkers and have an outlet in Hudson River. The contract for this sewer was let some time ago to the Mack Paving Co., of Philadelphia, Pa., at $1,800,000. It is now thought that work will be started about April 1.

The estimate by the Director of the Mint of the gold produced in the United States during last year is $89,620,399, against $94,393,800 in 1906.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750

NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt

BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

*SUBSCRIPTION RATES (Payable in Advance).— **$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*

***$2.50** a year (52 issues) to Dominion of Canada.*

***$3 00** a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Entered as second-class matter April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

Machine vs. Hand Drilling in Sinking Shafts 161
Methods and Plant Used in Placing Concrete and Masonry for Brooklyn Anchorage of Manhattan Bridge... 162
Methods and Cost of Constructing a Cement Storage House of Separately Molded Reinforced Concrete Members 165
Methods and Cost of Sinking a Shaft on the Rand, with Some Good Suggestions on Drilling.......... 166
Data on Steam Shovel and Grader Work at the Belle Fourche Dam... 169
The Report of the Canadian Government Commission on the Quebec Bridge Failure.......... 169
Twelve Letters Commending the American Society of Engineering Contractors 170
A Light for Contract Work.......... 172
METHODS AND COSTS:
Moving a Tank—Making Brick Aqueduct Water Tight—Data on Cast Iron Work—Underdraining a Basement—Laying Submerged Main—Securing Average Sample of Garbage 171

Machine vs. Hand Drilling in Sinking Shafts.

The article on shaft sinking in the Rand, which we publish in another part of this issue, brings up some interesting considerations of the comparative advantages of hand and machine drilling for shaft work. At present the most popular method is hand drilling. The advocates of hand work claim that five and seven compartment shafts being large, 46 x 9 ft., necessitate many machines, and long bars. This means a great waste of time and labor in hoisting these machines, to prevent damage to them in blasting. The large charges of explosives used in the deep holes made by machine drills shatter the shaft walls, while soundness of walls is essential. With machines, the timbering cannot be brought as near the bottom as with hand drilling, which is objectionable. Misfired holes interfere seriously with machine work, but not with hand drilling. With machines, the tonnage broken in one round of holes is so deep that the debris packs hard and cleaning out is more difficult.

Owing to the fact that machine work has not been done for any long periods it is difficult to compare footages with hand work, but the author of the article which we publish believes machine work will grow in favor because of the scarcity of labor.

When using machine drills two winding engines are essential to rapid progress, yet only one shaft sunk with machines was so equipped. In this shaft in favorable ground 150 ft. was sunk in a month. In some of the hardest ground on the field, the Rand Colleries shaft was sunk with machines 103 ft. in one month, only two buckets being at work.

Against these records are those of hand drilling, where 203 ft. was sunk in one month, the shaft being 28 x 8 ft. The monthly average for six months was 152 ft. The number of buckets hoisted per shift was 36, which would deepen a 34 x 9 shaft about 110 ft. per month. This shows the importance of winding capacity. With only a single engine, the whole mine must sometimes wait on one man.

The 7-compartment shaft at the Brakpan and Hercules mine, equipped with two engines has been sunk by hand 204 ft. per month. The use of air hammer or plug drills has not been a success on the Rand; the author thinks this may be due to the low air pressure employed in most mines, yet he thinks these drills do not seem to be able to stand up under the work. It might be stated here that the work done by plug drills in America in the past has been in comparatively shallow holes. Their use for holes of more than 30 ins. in depth has been limited, but from the experience that has been gained so far the manufactures are rapidly improving this style of drill. A record of plug drilling is given in ENGINEERING-CONTRACTING, Jan. 22, 1908, page 58.

The conditions most favorable for rapid sinking with machines are: (1) Maximum quantity of rock should be broken at each blast, as less time is lost in preparing for blasts and getting ready after blasts, for the tonnage moved. (2) By rightly judging the charge of explosive, the rock should be broken to the best size for rapid loading. This will depend upon the character of the rock, but rock, broken into pieces weighing from 20 to 200 lbs. is most rapidly placed by hand into buckets, while fine rock must be shoveled, consuming more time.

When water occurs with a greater depth of broken rock, dry shoveling can be had for a longer time, which is a consideration. When water gets on sandstones and quartzites having a large proportion of talcose and micaceous material, it is converted into a mass that is pudding-like and difficult to handle, unless done in the right manner. The author, besides having a sump from which the water is either bailed or pumped, runs an air hose down on each end of the shaft, and by means of a pipe inserted about 4 ins. into the ore mass, keeps the rock so well drained, that it can be shoveled fairly rapidly. (3) In as much as the last 10 or 15 tons of rock spread over the bottom takes the major portion of the time to clean up, it is obvious that, with the maximum quantity of broken rock on the bottom, which is easily available for picking and shoveling and raising with the buckets, the cleaning bears a less ratio to the total amount moved.

The length of hole to drill is one for consideration; the greater the length the less shifting and moving of drills and raising them from the shaft, but the hole should not be longer than will break clear to the bottom with one loading and firing. The holes, too, should be spaced so that in the series shooting there will not be misfires, caused by one hole robbing another. It is well to have all holes charted so as to prevent drilling into missed holes. Electrict blasting has never been found satisfactory, reliance alone being placed in the best fuse. Double fuses 12 ft. long are generally used. The best length of hole for 5 compartment shafts 34 x 9 ft. is 10 ft. in sump and 8 ft. for other holes. Longer holes would mean larger gages to bits, which means heavier steel to raise up and handle, which is as objectionable as length.

The author makes the following conclusions. Hand sinking on the Rand is somewhat quicker and cheaper than machine sinking. It involves less outlay of capital and is somewhat safer. For hand sinking there must be a large supply of labor.

Machine sinking, though more expensive, requires less skilled labor, and greater progress can be made through hard rock, there being no reason why with the best appliances the average of hard and soft material should not equal hand sinking.

Cost of explosives will be less in hand sinking as the amount of re-charging for re-firing holes is less than in machine drilling. However, where the shaft is sunk with machines and the sump and bench system is used, the amount of explosives used per ton approximates that of hand sinking. In the final paragraph the author says.

"Considering the shortage of labor, which will increase in the future owing to the repatriation of the Chinese and further development of other industries than mining in South Africa, I feel confident that on the Rand, air drills will rapidly increase in favor for shaft work."

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Methods and Plant Used in Placing Concrete and Masonry for Brooklyn Anchorage for Manhattan Bridge.[*]

BY GUSTAVE KAUFMAN[†]

The Brooklyn anchorage is placed diagonally over the intersection of Water and Adams streets. Its foundation is about 230 ft. long and 180 ft. wide, occupying an area of about one acre.

The anchorage is located about 700 ft. from bulkhead line of the East River. To obtain an overheard crossing of Plymouth St., which lies between the anchorage and the river, it is required by the contract that a trestle should be constructed from the dock to the anchorage for the transportation of materials of construction. This trestle, together with the dock, which was also required to be constructed, reverts to the city upon the completion of the contract. During the construction of the anchorage this trestle and dock may be used by other contractors doing work on the bridge.

The anchorage consists in general of an immense block of concrete masonry of 1-acre bottom area, having a shell of fine cut granite above the surface of the ground. The masonry starts at a depth of 25 ft. below the level of the ground or 12 ft. below mean high water, and will reach a height of about 105 ft. above the ground at the roadway of the bridge. In this mass of concrete the anchor bars are embedded to which the wire cables are to be attached. A very bold feature in the design is a 46-ft. arch passing through the anchorage from side to side to accommodate the traffic on Water St. after the construction of the bridge. The important items of work consisted of 40,000 cu. yds. of excavation, 100,000 cu. yds. of concrete, 14,000 cu. yds. of cut granite; 450 tons of reinforcing bars, and 1,300 tons of anchor bars; the whole work involving the handling of about 300,000 tons of material.

The work is divided into two divisions. The first, the larger bulk, embraces all that portion which must be completed before the construction of the cables can be started. The second division embraces that portion of the anchorage necessary to finish the work after the completion of the cables.

Under the terms of the contract, Division No. 1 is to be finished in 450 calendar days after March 1, under a forfeiture of $500 per day.

The task devolving upon the contractors was therefore to do all the work included in Division No. 1, which consists of 40,000 cu. yds. of excavation, 92,000 cu. yds. of concrete, 10,000 cu. yds. of granite masonry, 1,300 tons of anchor bars, together with a lot of other miscellaneous work, in 450 calendar days. From this time a liberal deduction must necessarily be made to permit the installation of the plant, for rainy days, Sundays, holidays and the intervening winter. In designing the plant it was estimated that, after deducting for these, there would be left probably 300 working days, and that therefore the plant and other arrangements must be such as to enable the execution of this vast amount of work in that time. Arc lights were installed to permit work to be carried on day and night.

The excavating was, at no stage of the work, considered to be a controlling feature, because during the time required for establishing the permanent plant, sufficient excavation could readily be done to permit the depositing of concrete in the foundations. Special plant for the purpose of excavating, consisting of two small traveling derricks, dump cars, etc., was installed. This readily did the work. Laborers in the pit shoveled the material into 1-cu. yd. dump buckets. These were lifted by the derricks and emptied into dump cars which were run on surface tracks to the dock, and there unloaded upon scows. The spoil was taken either to sea or to Greenville, where the Pennsylvania R. R. is constructing a new terminal. The excavation turned out to be very much more expensive than what was anticipated. At the corner of Washington and Adams streets there was formerly a large rolling mill, which had a very excellent foundation, set in cement. This had to be blasted out, together with a large number of boulders. The amount of excavation also largely exceeded the estimates, as will be shortly explained.

The water level was generally at about 14 ft. below the street and below this pumping was resorted to. This turned out not very formidable, and was done with two 6-in. centrifugal pumps, direct-connected with G. E. No. 52 electric motors. The lower 5 ft. of the excavation was principally sand, which packed very hard when slightly wet; this portion of the work gave more trouble to execute than any other part of the excavation. An orange-peel bucket was tried, but its operation was not very satisfactory owing to the fact that it would not penetrate into the hard packed sand. Quite frequently the operator would drop the bucket 5 to 6 ft. in an effort to secure penetration, and the results would be breakdowns and many repairs.

It was required under the contract to surround the whole area occupied by the anchorage with 12-in. sheet piling, driven to a depth of 3 ft. below the concrete foundation; the object of this was to provide a support for the banks and to restrict the excavation to the limits of the concrete foundation. It was soon ascertained, however, on account of the sandy nature of the soil, and also the frequency of large boulders, that it was impossible to drive the sheet piling with an ordinary pile driver. Moreover, it was developed that there were several layers of quicksand in the soil below the foundation and that it would be desirable to extend the sheet piling further into the ground so as to confine the sand. It was decided to carry them to a depth of 12 ft. below the foundation proper, and to accomplish this by jetting. On account of the difficulty of holding the banks during the jetting operations it was necessary to reverse the ordinary procedure and do the excavation first by sloping the banks and then to jet the sheet piling. The sloping of the banks increased the amount of excavation required to be done by about 13,000 cu. yds. This amount was further increased in jetting in the foundation piles. It was discovered that the piles displaced the sandy and gravelly subsoil, it being impossible to compress it. This displacement amounted to about 2,000 cu. yds., making the total excavation 55,000 cu. yds. instead of the estimated quantity of 40,000 cu. yds. The excavation was finally completed the latter part of August, 1905, at no time retarding the pile or concrete work.

The driving of 27,000 lin. ft. of foundation piles was included in the contract, but it was decided to put in foundation piles over the whole area. These piles were about 40 ft. long and were jetted and driven into place. This work was exceedingly difficult on account of the frequency of gravel and boulders. The jetting plant consisted of a 14x8-in. plunger pump, capable of giving a pressure of about 200 lbs. per sq. in. with ordinary boiler pressure. A 4-in. discharge pipe was used to carry the water to the pile drivers. Three pile-driving crews were supplied with jets from this plant, two of which worked upon the foundation piles and one on the sheet piling. The driving of the foundation piles was carried on day and night, but the sheet piling was driven only during the day, owing to the care which was required to keep them in alignment.

An interesting engineering feature in connection with the pile driving consisted in the sinking of gravel and boulders, containing probably 12 or 13 cu. ft., to a depth of 30 to 40 ft., and the washing out of the lighter soil. The effect of this operation was to produce an irregular layer of gravel and boulders, at a depth of about 35 ft. below the concrete foundation of the anchorage, extending over the whole area. The water pressures obtained at the pile drivers varied generally from 120 to 150 lbs. Had the pressure been greater, say, 500 or 600 lbs. per sq. in., the author feels justified in asserting that much larger boulders could be sunk to a depth equal to the length of the jet pipe. In the author's opinion the use of the water jet for engineering purposes, especially for foundations, has not yet been developed to its full possibilities. It can afford solutions for many doubtful problems.

---

[*] Abstract of a paper read before the Brooklyn Engineers' Club, May 10, 1906, and published in the Proceedings for 1906, p. 152.

[†] Chief Engineer, Kosmos Engineering Co., Brooklyn, N. Y.

The material required for the work consists of crushed stone, sand, cement, large irregular blocks of granite or cyclopean stones, which are to be imbedded in the concrete, cut granite and miscellaneous matter. All this material is contracted for to be delivered by water, and, owing to the large quantities required to be handled, ample provisions for dockage of scows were necessary. The plant required naturally divided itself into four parts, namely: That required to receive and unload the material at the dock; the transportation of same to the anchorage; the placing of same into position, and for mixing the concrete. It is, of coures self-evident that the handling of the material should be reduced to a minimum. In conformity with this the concrete mixing plant was located close to the dock to enable the concrete material to be loaded directly into it. Owing to the rapidity with which the concrete material was to be handled no storage for this material was deemed necessary, the scows being used for this purpose. Storage in the scows is merely nominal because generally a scow load of stone or sand will be unloaded in one or two days. In regard to cement, this is generally delivered in boats containing 3,000 barrels. The boat is first held the proper time prior to unloading to permit the testing of the cement. After it has passed inspection the cement is unloaded directly into the mixer. One or two thousand barrels are kept on hand for emergency.

The stone for the granite facing is delivered cut, ready to be set in place, but, inasmuch as it is not shipped exactly in the order wanted, it is necessary to distribute it in proper storage yards.

It is also impossible to take all of the cyclopean stone directly from the boat to the work, a certain amount of storage and rehandling being required for this material.

An additional advantage is obtained in placing the concrete mixer near the dock in preference to locating it close to the anchorage, because it is more economical to transport the concrete rather than the materials required to make it. The reason for this is because the concrete occupies probably 40 per cent less bulk than that of the materials entering into its composition when handled separately.

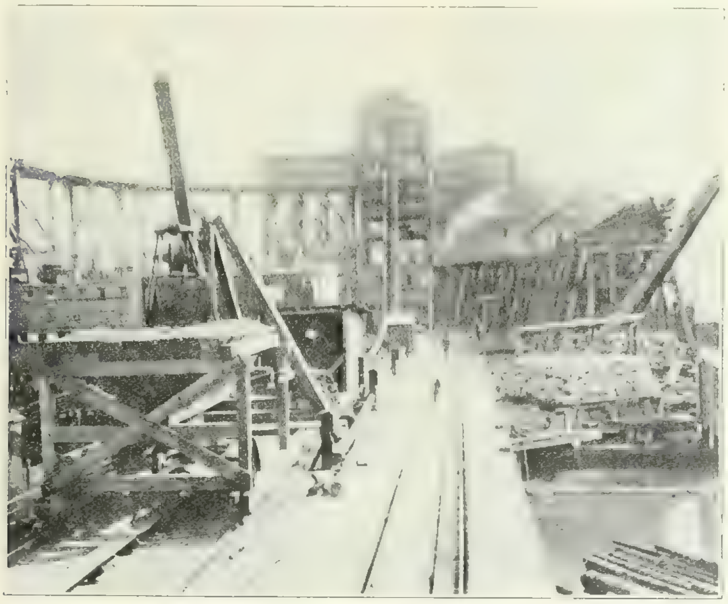


Fig. 1—Hains Concrete Mixer and Clam Shell Bucket for Loading Stone Into Hopper That Feeds Belt.

The author's experience with the Hains gravity concrete mixer during the construction of Division No. 1 of the Atlantic avenue improvement [Brooklyn, N. Y.] determined the selection of this type as being probably the most economical and of the largest capacity. Figure 1 shows how this was constructed and located. It was necessary to construct it of the very great height of 90 ft.; 26 ft. of this is due to the fact that the trestle, which is shown to the right of the picture, is of that height. The bins on the top of the mixer are somewhat larger than usual, thus increasing the height. There are three bins, the two outer ones are for stone and the center one for sand; their capacity is about 100 cu. yds. for the former and 50 cu. yds. for the latter. The view shows clearly how the material is carried to the bins. The clam-shell bucket deposits the stone and sand into the hopper shown in the foreground. A mechanical shaking device at the bottom of this hopper, feeds the stone and sand in small quantities onto a horizontal belt conveyor 200 ft. long, extending along the dock. This belt conveyor discharges the material into a bucket elevator, which, in turn, carries it to the top of the mixer. The capacity of this machinery, together with that of the bins, enables the alternate use of it for stone and sand. The cement is lifted on to the trestle shown to the left and placed on small cars, which men push into the small storehouse shown adjacent to the mixer. Most frequently, however the cement is taken from these cars and placed directly into the measuring hoppers on the working platform.

The water required for mixing the concrete is taken from an artesian well, 60 ft. deep, which was drilled by the contractors. The water is pumped from this by an automatic pump to tanks placed on the top of the mixer; suitable floats break the electric current when the tank is full and stop the pump, and reconnect the circuit again at any desired height. About 30 gallons of water per cubic yard of concrete are required. The cost of pumping is about 3 cts. per 100 cu. ft., while the cost of city water would be 10 cts. per 100 cu. ft. The tank is placed about 100 ft. above the ground. This water is also used in setting the granite masonry.

The materials of construction are transported from the dock to the anchorage by means of an electric railway operated by means of a third rail. The voltage used is 220. The use of an overhead trolley would be more economical, but it is not practical because it would interfere with the hoisting of material to the anchorage. The electric car or locomotive is very powerful, being capable of pushing 15 tons up 3 per cent grades and around 50 ft. radius curves. Three cars like this are used, each being equipped with two No. 60 G. E. electric motors, railway type. The track system is quite elaborate. There is a double track railway on the trestle extending from the mixer and then branching to both sides of the anchorage. At the rear of the anchorage these two branches are connected with a single track. There is a surface track running from the end of the dock to the anchorage, and this also branches to both sides and connects with the tracks on the trestle. This arrangement of tracks permits the delivery of material wherever wanted, and allows the derricks of the travelers to reach the load from any location.

The determination of the best method for taking the material from the cars and placing same in the anchorage required a great deal of study. This is really the controlling feature of the whole work, as ample capacity must be provided to handle the enormous quantities so that the work could be completed in time. The work being 230 ft. long and 180 ft. wide, hoisting appliances that could reach all parts of the work had to be installed. A number of schemes were considered—namely: cableways, overhead cranes spanning the whole work, steel towers embedded in the concrete with derricks placed on top of them. All were seriously considered, but were rejected for some good and valid reason, and it was finally determined to construct two enormous travelers with platforms 28 ft. wide and 47 ft. long, having derricks with 60 ft. booms in each corner. They are placed upon wheels, so that they may be moved backward or forward as required. The traveling derricks appear to meet the requirements very satisfactorily. As the work is built up they, together with the tracks upon which they run, are lifted up by means of hydraulic jacks, and moved onto completed work. Figure 2 shows the method of jacking; the height to which it was lifted, as shown on this view, is about 16 ft., which is about three times higher than what is usually done. The travelers have sufficient number of derricks to permit the two classes of workmen—namely: the masons and the concrete men—to work without interfering with one another. They are very heavy, weighing about 80 tons each. The original idea was that they would be lifted about 6 ft. at a time and then moved forward on completed work. The non-delivery of the anchor bars and girders has caused a very material change in the method of executing the work, and the occasion thereby arose by which it was necessary to lift the travelers 16 ft.

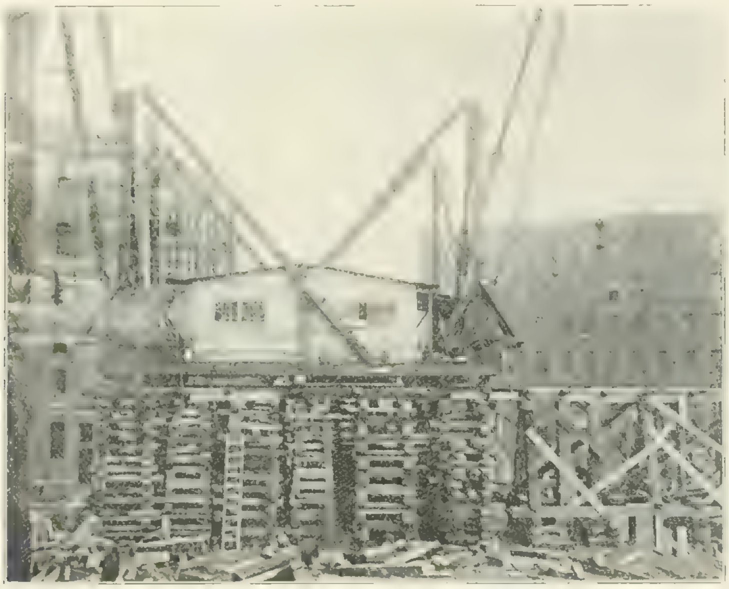


Fig. 2—Traveler After Being Jacked Up 16 ft.

The capabilities of the plant were very clearly demonstrated in putting in the concrete for the base of the anchorage; this contains over one-third of the concrete to be put in Division No. 1. This work was started in the early part of September and finished the early part of December. This mass of concrete contains about 33,000 cu. yds., so that the average monthly work done consisted of about 10,000 cu. yds. of concrete. The work done during this period therefore about equal the capacity contemplated. The greatest day's work of 20 hours was about 1,000 cu. yds.; this was for day and night work. Very frequently 500 cu. yds of concrete were put in in 10 hours. It was found impossible to keep up this gait all the time, for the reason that the machinery would require repairs and renewals, and because the material men could not get the material to us quickly enough. It was, however, necessary to have a plant of this capacity in order to make up for lost time when the opportunities presented themselves.

Owing to the very unsatisfactory operation of the law by which steam engineers are licensed, the use of steam power in this city is generally avoided by contractors whenever possible to do so. For this reason the operation of the plant used on the work here described is by electricity. The author is not yet able to state with any degree of positiveness whether it is more economical than steam; he is, however, justified in stating that it is much less troublesome and a great deal more reliable.

At the beginning of the work the question as to whether a generating plant should be installed or whether the power should be purchased from the Brooklyn Edison Co. was settled in favor of the latter for the reason that it was estimated that the total cost of the electric power required would not equal the cost of constructing a suitable plant. The original estimate of the total cost of the electric power was made by taking the total weight of the structure and assuming that the average height to be lifted was 80 ft. and the speed 40 ft. per minute. The theoretical result obtained was multiplied by 8 to cover friction, rehandling, etc.; so far it appears that this was not far out of the way.

The derricks are all operated by the latest pattern of electric hoists; these hoists have double drums to permit hoisting the load, raising and lowering the boom, and they are also equipped with reversing boom swinging devices. One operator for each hoist controls all the movements. The hoists are provided with automatic brakes, which will catch the load should the electric power give out suddenly. The plant requires 14 hoists of this description. The belt conveyor, the bucket elevator and the automatic pump are also operated by electric motors. There are also the three electric cars, before mentioned, which are used for the transportation of the material, so it can be seen that the electric installation is quite extensive for a contractor's plant.

The use of electric power enables the determination of the number of points, which have never hitherto been known. For instance, one can determine what power is lost by friction in the hoisting engines and derricks, what power it actually takes to lift a load, and also to swing same into position. The extra cost of the power per lift can in this way be determined.

In operating the clam-shell bucket, the power and cost of closing the bucket, lifting same, swinging the load and returning the empty bucket can be ascertained.

To give a full and proper account of the knowledge gained by the use of electricity would require another paper. In order not to extend the length of this one too much the author will conclude by giving a few figures relative to electrical matters which may be of interest:

The total horse power installed is 457.

The average horse power hours used is 14 per cent of the total installation.

The highest percentage of the installation running at any one time is 42 per cent.

The greatest average load factor for one day's operation is 27 per cent.

The wiring is all installed at 33⅓ per cent of the load factor, with a 5 per cent drop.

CENTRIFUGAL PUMPS USED WHILE EXCAVATING.

Six Inch Suction and Discharge.

Total lift	33 ft.
Catalogue capacity	1,600 gal. per min.
Rough gaging	550 gal. per min.
Theoretical horse power required for catalogue rating	13.5 h.p.
Theoretical horse power required for gaged output	5.0 h.p.
Actual horse power consumed	26.7 h.p.

This, of course, includes friction in motor, pump and pipe.

POWER PUMP OPERATING ARTESIAN WELL.

Three-Plunger, Single-Acting Pump, Geared to 3 H. P. Electric Motor, 220 Volts.

Length of stroke	6 ins.
Diameter of plunger	4 ins.
Crank shaft speed, revolutions per minute	50
Suction	2½ ins.

Discharge, 2 ins., changing at pump to 2½ ins.	
Total lift, including suction	90 ft.
Total length of discharge	342 ft.
Theoretical horse power required	0.85 h.p.
Electrical horse power input	2.30 h.p.
Motor at 90 per cent efficiency supplies pump	2.07 h.p.
Electrical horse power required to run pump free	1.40 h.p.
With motor at 85 per cent efficiency the pump absorbs in friction	1.18 h.p.
The actual horse power therefore to pump the water through 342 ft. of 2½-in. pipe against 90 ft. head is 2.07 h.p.—1.18 h.p.	0.89 h.p.
The theoretical horse power as above	0.85 h.p.
The horse power lost by friction in the pipe	0.04 h.p.

This agrees very closely with results obtained by use of Weisbach's formula.

BELT CONVEYOR.

Material—Crushed Stone.

Distance carried, feet	207
Cubic yards conveyed per hour	63.3
Velocity of belt, feet per second	6.2
Horse power required, belt running light	3.46
Horse power required, belt loaded	4.38

BUCKET ELEVATOR.

Material—Crushed Stone.

Height lifted, feet	87
Weight, pounds per minute	2,640
Theoretical horse power required	6.96
Horse power required, elevator empty	4.06
Horse power required, elevator full	11.16
Efficiency of elevator, per cent	62.3

TESTS ON 60-FT. DERRICKS.

Load lifted, pounds	12,000
Horse power required to lift load 15 ft.	23
Horse power required to lift boom from an angle of 30° to 60°	31
Horse power required to swing the load	18

Methods and Cost Of Constructing a Cement Storage House of Separately Molded Reinforced Concrete Members.

The construction of a kiln house of separately molded reinforced concrete columns, girders and slabs for the Edison Portland Cement Works at New Village, N. J., was described in our issue of Oct. 2, 1907. This article gave for the first time costs of molding and erecting separately molded concrete structural members for building work. Since it was published the same company has built a cement storage house for which the columns, girders and roof slabs were separately molded and erected. In a paper read by Mr. W. H. Mason, superintendent Edison Portland Cement Works, some of the costs of this later work were given. We give these costs in different form and more fully analyzed in the following paragraphs.

The storage house is 144x360 ft., in plan with a clear height of 30 ft. The exterior walls are of retaining wall section, they having to take the thrust of the stored cement, and they were built in place. Between walls are five longitudinal rows of columns; the rows are spaced 24 ft. apart and the columns in each row are 12 ft. apart. Transverse roof girders 12 ft. apart cap the columns and carry a roof of 6x12 ft. x 4-in. slabs. For column footings 5x5x5-ft. plain concrete cubes with 20-in. square sockets molded in their tops were used.

Materials and Labor.—The concrete used was a 1-6 mixture, using crusher run stone, all of which would pass a ¾-in. screen. The Edison company furnished both cement and stone, charging up the cement at $1 per barrel and the stone at 60 cts. per cu. yd. The lumber, of which 7,000 ft. B. M., were used, cost $27 per thousand. The reinforcing steel, of which 201,400 lbs. were used, cost delivered 2.03 cts. per pound. A force of 23 men was employed; eleven of them were classed as carpenters at an average wage of 24 cts. per hour and 12 as laborers at an average wage of 15 cts. per hour.

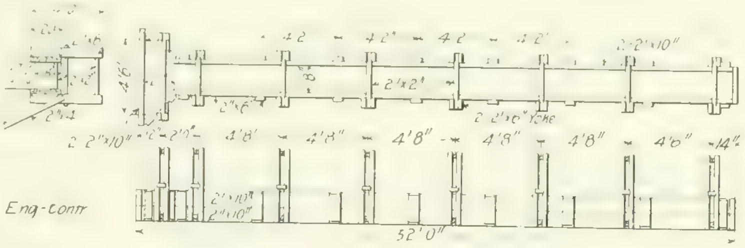


Fig. 1—Form for Concrete Columns.

Casting Floor and Plant.—The casting floor on which the columns, girders and slabs were molded, was located some half a mile from the building. A ½ cu. yd. Ransome mixer was set up under the mill conveyer which carries crushed cement rock for cement making to the stock house and from this conveyer the stone was chuted directly into the mixer stock bins as wanted. The mixer discharged directly into 3 cu. yd. cars which ran out on a track between casting floors on each side. The casting floors consisted of trowel finished concrete slabs 4 or 5 ins. thick laid on a 4-in. sub-base of compacted cinders. These casting floors cost, Mr. Mason states, 4 cts. per square foot. So far as possible, members were cast side by side and in tiers so as to reduce floor space and form work. The concrete cars discharged by spout directly into the molds, the mixture being made wet enough to flow easily.

Molding Columns.—There were 141 columns, having 18x18-in. shafts 32 ft. long with two triangular brackets at the top for girder seats, and each column contained very closely 2.8 cu. yds. of concrete and 275 lbs. of reinforcement or closely 98 lbs. of steel per cubic yard of concrete. These quantities are computed from drawings. The construction of the forms for molding the columns is shown by Fig. 1. Each complete form contained about 535 ft. B. M. of lumber and seven were used for molding 141 columns and were still in good condition after the work. The seven molds contained about 3,745 ft. B. M. of lumber and molded 141×2.8=395 cu. yds. of concrete, so that the amount of form lumber used per cubic yard of concrete molded was about 9.7 ft. B. M. The costs of molding per column and per cubic yard were as follows:

Item.	Per Col.	Per Cu. Yd.
Steel reinforcement	$7.57	$2.70
Concrete materials	5.48	1.96
Labor, carpenters	4.27	1.52
Labor, concrete and steel	1.95	0.70
Total cost	$19.27	$6.88

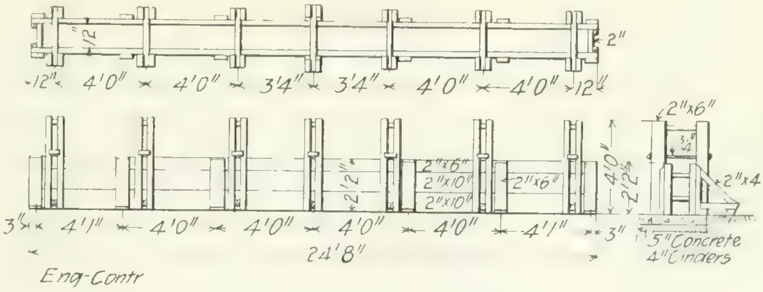


Fig. 2—Form for Concrete Girder.

Molding Girders.—There were 187 girders, each 12 x 26 ins. x 24 ft. and each containing 1.9 cu. yds. of concrete and about 320 lbs. of steel or about 168 lbs. per cubic yard of concrete. A complete girder form is shown by Fig. 2. A complete form contained approximately 370 ft. B. M. of lumber and five forms, or 1,850 ft. B. M., were used for molding 187 girders, or about 5.2 ft. B. M. per cu. yd. of concrete in girders. It should be noted that many of the girders were molded between other girders without using any wooden forms at all. The average cost of molding a girder complete as follows:

Item.	Per Girder.	Per Cu. Yd.
Steel	$5.53	$2.91
Concrete material	3.51	1.90
Carpenter labor	2.26	1.18
Labor, mixing, placing, etc	1.34	0.70
Totals	$12.64	$6.69

Molding Roof Slabs.—The roof slabs were 6 x 12 ft. x 4 ins. and each contained 0.88 cu. yds. of concrete and about 83 lbs. of reinforcing steel or about 95 lbs. of steel per cubic yard of concrete. The slabs were molded in tiers, using the form shown by Fig. 3, made 8 ins. deep so as to be clamped onto each slab in molding the slab above. There are about 52 ft. B. M. in a slab form, as 28 forms molded 720 slabs, about 2⅓ ft. B. M. of form lumber were required per cubic yard of concrete. The cost of molding roof slabs was as follows:

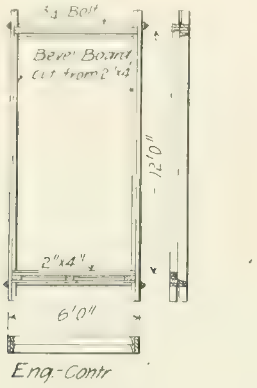


Fig. 3—Form for Concrete Roof Slab.

Item.	Per Slab.	Per Cu. Yd.
Steel	$1.60	$1.02
Concrete material	1.85	2.10
Carpenter labor	0.423	0.48
Labor	0.405	0.46
Totals	$4.308	$4.06

Each slab covered 6 x 12 = 72 sq. ft. of roof, so that the cost of molding was 6.06 cts. per sq. ft. or $6.06 per 100 sq. ft.

In casting columns, girders and slabs side by side and in tiers in contact the fresh concrete was prevented from adhering to the member already molded by coating the contact surface of the molded member with two coats of ordinary whitewash. This method proved far superior to using paper, as had been done in previous work (Eng. Contr., Oct. 2, 1907). The paper stuck to the concrete so fast that it was difficult to remove it. It should be noted also that in the preceding cost figures the cost of form lumber is apparently included in "carpenter labor." There was 7,000 ft. B. M. of form lumber at $27 per M. ft. required for molding 1,048 members, or about 1,384 cu. yds. of concrete. The cost of form lumber per cubic yard of concrete was, therefore, $189 ÷ 1,384 = 13.65 cts.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Methods and Cost of Sinking a Shaft on the Rand with Some Good Suggestions on Drilling.*

Bore-holes had shown that the ground to be sunk through on this property was largely composed of interbedded diabase sheets. The largest one was of exceptional hardness and toughness, consisting in its core of a fine-grained aggregate of pyroxene and labradorite crystals. The other diabase sheets were of varying hardness, being somewhat decomposed, but these sheets had all re-silicified the quartzites in their immediate neighborhood, rendering them much harder than the average. Mr. G. A. Denny, the consulting engineer to this company, owing to the character of the ground disclosed, decided to use machines for sinking. He was also responsible for the design of the timbering used. For a depth of 50 ft., while in the soft clay and surface soils, these shafts, there being two on the mine, were excavated 3 ft. larger than the normal size. When solid rock was reached a bearer set was placed in position; then the shaft was timbered to surface and closely lagged. The space between these sets and the temporary timbering was completely filled with concrete, making the shafts absolutely secure. The large steel collar set was then carefully placed in position and bolted down.

A small steel head-frame and temporary hoisting engine was then placed in position, the intention being to proceed at once with the erection of a permanent headframe and engines. For various reasons this program could not be carried out, and only one engine has been available for sinking. The engine in use is a geared two-cylinder 16x32-in. engine, made by Robey & Co., England, having two 8-ft. drums, provided with clutches. Two similar engines are installed at one of the large four-compartment shafts being sunk to 4,000 ft. by the Brakpan Mines, Ltd.

The shafts at the Rand Collieries, Ltd., have five compartments and are about 34 x 9 ft. between rock. These shafts were sunk with air drills, and a center V-cut was used. The shafts are timbered throughout their whole depth.

When buckets and detachable hooks are used three buckets can be employed for hauling rock; then one bucket is always on the bottom being loaded. When working with three buckets in this shaft, the bucket, coming down empty in one compartment, is swung over underneath the other compartment by means of a short iron hook, having a handle, about 4 ft. long; this is hooked into the ring on the bottom of the bucket. The bucket is unhooked when properly landed; the rope and shackle are then rung up the shaft to have the spare bucket attached, while the one on the bottom is being filled. The other empty bucket comes down just over the full one and this is swung under the other compartment, leaving a space of about 5 ft. between the buckets. Two workers can easily unhook the buckets and hook the other on again, without climbing on top of the buckets, which hold about a ton.

The laborers on the far side of the bucket begin to fill it immediately on its arrival at the bottom and while the loaded bucket is being attched; during this time the workers on the other end of the shaft are picking over the bottom. The loaded bucket, standing as it does immediately under the rope in the compartment through which it will be hoisted, rises without any swinging.

The use of three buckets does not save much time when the trip in the shaft does not take more than 1½ minutes because that amount of time can be employed to advantage in picking over and loosening the material on the shaft bottom. If the material is thoroughly loosened, 16 shovelers can load the 20 cu. ft. bucket in one minute. Time is lost in cleaning out, when workers have to dig or scrape up the broken rock; hence it is a mistake not to spare some time for properly loosening the rock so as to enable all to work at high pressure. About six laborers only use picks; these rest or pick the far ends of shaft, while the buckets are being filled by the 16 to 18 laborers, detailed to shoveling. The buckets are tipped over doors on the surface by hand or with the aid of a block and tackle.

Ventilation in all modern shafts is provided for by carrying down a timber brattice in the center of a seven-compartment shaft or between the pump and hoisting compartments in a five-compartment shaft. Planks, 1¼-ins. or ⅞-in. thick, are used. These are scribed against the irregular sides of the shaft, making a fairly airtight partition. Natural ventilation clears the smoke out quickly, consequently men are sent down to clean the timbers, almost immediately after the blasts have exploded. Signals are given by ⅜-in. galvanized steel bell lines. These are hauled up some distance before blasting.

The routine of shaft sinking with machines, at the Rand Collieries, Ltd., is as follows: Three white men work 8-hr. shifts and supervise the cleaning out of the shaft and help during the drilling shift. These are paid £1 ($4.86) per shift. Three whites and a foreman and about 25 natives or Chinese comprise the drilling crew. These go down in rotation after a blast; their task is to send up 60 buckets of rock, or, when the bottom has to be scraped, only 50 buckets. There are about 25 natives or Chinese on each of these mucking shifts. The white men on the drilling crew get 25s., or $6, per day. They have to do the drilling and they also have to go down, when required to assist in blowing out holes for second blasting and to help clean down the timbers and to lower hose ready for the drilling shift. Natives and Chinese get 2s. (48 cents) per shift with 6d. or 1s. (12 or 24 cents) for work performed within a specified time. A bonus, depending on the equipment of the shaft and the class of ground passed through, is also given per foot greater than a certain footage per month. In future these bonuses will, no doubt, be greatly reduced.

---

*Condensed from an article by Mr Eustace M. Weston, Manager Rand Collieries Ltd., Brakpan, South Africa, in the Engineering and Mining Journal, Feb 22, 1908.

As soon as the ends of the shaft are cleaned up, blocks, wedges and bars are sent down and the end bar rigged up. Hose are lowered and any defective ones replaced; any stumps of holes are blown out and plugged. Then, when the center of the shaft is cleaned out the drilling crew comes down and work is started.

Where the ground is shattered by jointings or where drilling has to go on under water so that there is a danger that rock fragments will wash into the holes, collar pipes are driven into the mouth of the hole. These are pieces of old pipe or boiler tube about 12 ins. long, having a 3-ins. to 3½-ins. diameter inside. These help the drilling greatly for the hole "muds" better than when drilling under water, for it can splash when these are used. After the hole is loaded, when it is possible, these pipes are drawn so as to be used again. When the ground is of such a character that the mud tends to settle in the bottom of the hole the hole is pumped out, whenever a drill is changed. For this purpose, pipes, 3 to 12 ft. long and from ¾ to 2-ins. diameter are used. They are moved rapidly up and down in the hole while the hand is used as a valve at the top of the pipe. The pipe is kept closed on the up stroke and the hand is taken away on the more rapid down stroke. This throws the mud and water out. In other places elaborate pumps, made with a plunger and a marble, or other valve, at the bottom, are employed. Ordinary blow-pipes are also used here, but only when coarse grit or rocks in the holes render their use necessary.

A single snatch-block is hung from the lowest set of timbers and a rope and hook are used to hoist the machines in and out of the buckets and to swing them into position in any part of the shaft. The machines are rigged on clamps directly off the bars, which are 8 ft. long and 4½ ins. diameter. There is no difficulty in making a secure set-up. Occasionally the bars have to support four machines at work, but generally two are placed on each bar except the one on the pump end which carries three.

MACHINE DRILLING IN HARD ROCK.

The drilling of long holes in the shaft-bottom, when the ground is full of points and slips, requires considerable skill. In hard ground a close watch has to be kept, so that drills are not kept at work after they are too dull, otherwise the drills will either bend or break, or else it will be found impossible to get the next drill to follow. Re-alining a drill in a hole, that has "run away," is not so easy as it is when an arm is used on the bar, for no change in vertical elevation can be made. If a hole gives trouble the jig bolt is first slackened a little, then the clamp is moved along the bar, in whatever direction may appear best, and the bolts tightened again. If trouble is still apparent the clamp bolts are loosened a little, while the machine is running; then very often the machine will aline itself. The following trick used when a bit is slightly too large for the hole, is certainly bad practice, but, nevertheless, it is often useful: The chuck bolts are loosened and the machine is cranked back so that the chuck is used as a hammer to strike the shank of the drill; meanwhile the drill is turned by hand. The hole can thus often be reamed out and the drill made to follow.

The miners going down after blasting examine the timbers for loose rock, re-lay the staging and pick down the walls of the shaft. The shaft timbers are examined beginning about 200 ft. above the bottom; but there is always a chance that loose rock will afterwards fall down the shaft. The timbermen are assisted by natives or Chinese, so that there is also always the danger of tools and wedges falling to the bottom. Hence work on the shaft bottom is always dangerous, although, fortunately, each blast tends to bring down any loose rock from the sides or on the timbers.

In shaft sinking the keeping of a log book is essential for checking the work done. It shows the time consumed in drilling, cleaning out, lowering timbers, cleaning down shaft, etc. Any falling off in efficiency is at once shown and its reason can be sought. The following (Table I.) is a specimen of log book kept at this time for machine sinking. This log also indicates fairly well the time consumed in the different operations of sinking this shaft.

In this shaft the best cleaning-out done was 60 buckets hoisted from 2,100 ft. in 3 hrs. 40 mins., including 10 mins. spent in coming down to work. With four buckets at the Village Deep shaft 80 buckets of rock have been hoisted in 3½ hours from a depth of about 1,500 ft. At the Brakpan shaft 107 buckets have been hoisted and the shaft drilled over by hand in eight hours.

As there was no drill-sharpening machine at this mine, bits of star section could not be jumped up and formed from the steel. Consequently one had to follow, what is the usual custom in this field, of using for all cross-bits, star-section steel welded upon octagon steel. There are in fact only a few mines on the Rand equipped with machines for sharpening and making machine drill-bits. In this respect American practice is far in advance, when really hard ground has to be drilled. Welds, however well made, are always a source of weakness and trouble.

The diabase in this shaft was of exceptionally hard and tough character. Therefore during the drilling shift it was necessary to have a blacksmith always available to sharpen drills to any gage required owing to bits wearing abnormally or shattering. Star bits had to be employed up to a length of 7½ ft. as chisel bits lost their gage too rapidly. At the Village Deep shaft, where the rock was favorable for drilling, only chisel bits were used, after the starter had "pitched" the hole.

Owing to the use of welded steel, breakage of drills was frequent and holes were repeatedly lost owing to this cause. Nothing is more anoying and disheartening to the operator than to have a 6-in. end break off in a 5-ft. hole that had required, as was frequently the case, three hours' drilling to reach that depth. It was found impossible to devise any really sat-

TABLE I.—LOG FOR SHAFT SINKING WITH MACHINES, RAND COLLIERS, LTD.

December, 1906.		Buckets Hoisted.		Time of Shift.		Length Shift.		Time Lost.					
								Timber Cleaning.		Lowering Wall Plates.		Blasting.	
Date	Shift.	Rock.	Water.			Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.
5th	Drilling		6	1:40 a. m.	4:10 a. m.	14	30	1	25				
	Muck'g 1st	60		5:35 a. m.	10:10 a. m.	4	35			1	35		
6th	2nd	50		11:45 a. m.	3:20 p. m.	3	35						
	3rd	50		3:20 p. m.	11:45 a. m.	5	55					1	30
7th	4th	20		12:15 a. m.	3:45 a. m.	3	30						
Total buckets hoisted		180		Total time sinking		17	35	1	25	1	35	1	30

Total time for round = 36 hr. 35 min.
Footage sunk for week = 28 ft. For month = 103 ft.
Ground sunk through, hard diabase.
Number of machines for drilling on shaft bottom, 11

isfactory tongs or other extractor for regaining these ends. When drills stuck in holes, owing to bending or other causes, a clamp extractor, Fig. 1, was found very useful.

The air pressure that we used in hard rock was 80 lbs. per sq. in.; when in the hardest rock, we found it better to reduce this to 70 lbs., for, though the speed of drilling was much reduced, fewer drills were broken and fewer holes were lost on that account. But, when the shaft bottom was in quartzites of moderate hardness, 90 lbs. pressure was employed and it resulted in much more rapid drilling. In such rock three 8-ft. vertical holes are easily drilled in two hours; at the producing mines in rock of the same hardness, with the pressure there employed, 22 ft. of hole is the average amount drilled during an 8-hour shift.

Only the best brands of chisel steel, costing 11 to 12 cts. per pound, would stand in this diabase without bending; but, for the longest drills, having chisel bits and 11 ft. long, 1-in. steel was found to stand satisfactorily with the 3¼-in. machines. Next to the welds, the worst breakage of steel occurred at the shanks. The ends of the shanks were most carefully hardened to prevent burring up, but they broke badly just outside the chuck, where the diameter was reduced by swaging to form the shank.

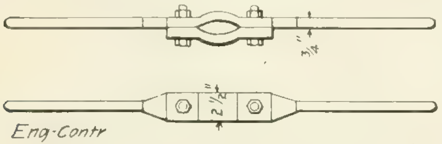


Fig. 1—Clamp Extractor for Removing Drills.

The patent Simplex chuck, manufactured by Stephens, of Camborne, England, Fig. 2, is much better than the ordinary English and American chucks. Steel of ordinary octagonal section can be used without shanking. As shown in the accompanying cut, the side of the chuck is cut away and the long pad or key clamps the steel against a half-chuck bushing on the other side. Wear on this bushing can be cheaply taken up by liners. The key is easily tightened or loosened by a tap of a hammer. A great saving of bushings and in the cost of shanking results when this chuck is used.

The machines in use here are 3¼-in. Ingersoll-Sergeant drills, equipped with an auxiliary valve, and the 3¼-in. Holman air-valve drills. Generally, the American machines were preferred for, as they were made of better material, they required fewer repairs; no great difference in the speed of drilling was noted. Eleven machines are used in the shaft bottom. At the Village Deep shaft twelve machines, rigged on four bars, were used. Here eleven machines were sufficient. The hoisting buckets work in the two compartments, 5 ft. long, next the pump compartment. The pump compartment is 8 ft. long. When the sump or cut is taken out under the two hoisting compartments there is a space of about 13 ft. at one end of shaft and of 10 ft. under the pump compartment end. Five bars are rigged, two under the pump end and three under the two unused hoisting compartments. Five machines drill 15 holes on one side of the cut and six machines drill 18 holes on the other side of the cut. If any extra holes should be required there is always a machine that has finished its holes, before the machines drilling the center holes are through, and it is available for the work. The distances apart of the bars and the arrangement of holes are shown by Fig. 3.

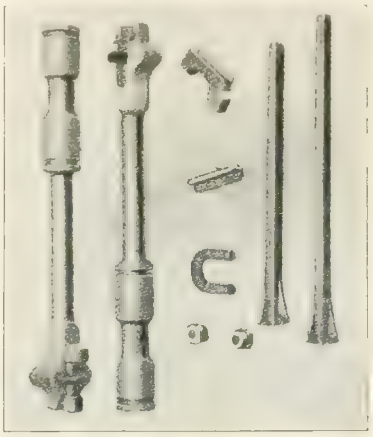


Fig. 2—Simplex Drill Chuck.

The air is carried down the shaft in a 6-in. pipe, placed in the pump compartment. A double platform is put in over the pump compartment and the two unused hoisting compartments. A cross piece of 4-in. pipe, provided with cocks, is run across the shaft; five hose are coiled on hooks, hanging from the shaft timbers on one end and the other six on the other end. At first these hose were 100 ft. long and the stage kept from 60 to 100 ft. from the bottom, the 6-in. pipe being lengthened whenever a distance of 40 ft. was sunk. In really hard ground, however, the hose and platforms suffered too much from flying rock. Hose, 150 ft. long, were therefore used and the platforms kept further from the bottom. Six natives and a white man are sent up, just before the drilling of the round is completed, to haul up the hose. Two of the natives remain on the timber platform about 40 ft. from the shaft bottom; thus the hose, though heavy, are easily and quickly hauled up.

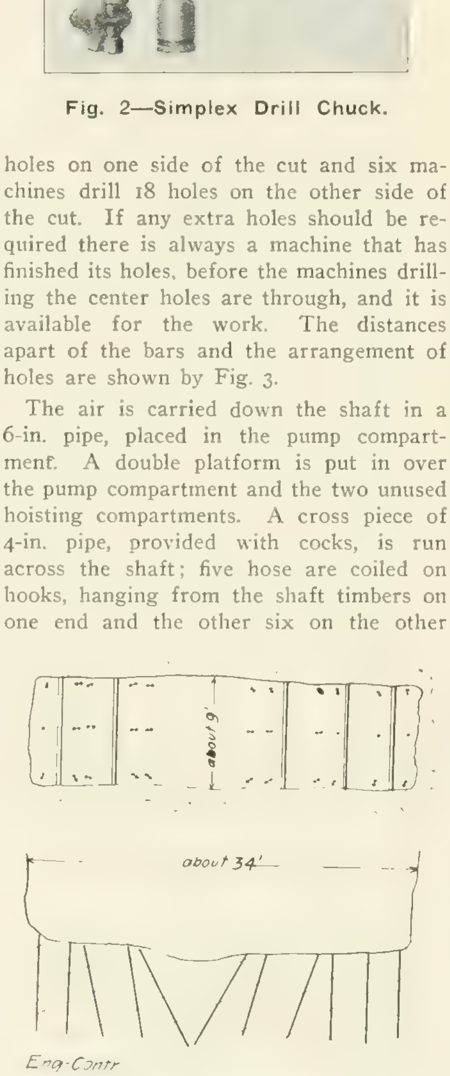


Fig. 3—Diagram Arrangement of Drill Holes.

In some cases all the hose are attached to one detachable pipe and are counterbalanced by a weight on a rope passing over a pulley high up in the shaft. This pipe is taken off just before blasting and hoisted high enough so that the hose hang high enough in the shaft to be out of the way of flying rocks. This method has the disadvantage that excess length lowered must be taken up again and the hose secured with rope; besides, all the hose must be lowered, when only one is required at each end of the shaft for blowing out holes, etc.; the remainder are then in the way of timbering and shoveling. The platform method, though it is expensive and troublesome, is perhaps the most convenient.

The costs of sinking these shafts during certain months are shown in Tables II. and III.

Table II.—Cost of Sinking No. 1 Shaft.
(August, 1907; 131 ft., sunk through hard quartzites.)

Winding ropes and bell lines	$ 0.224
Tramming	4.273
Sinking*	37.513
Cleaning up broken rock	19.477
Pumping	5.420
Hauling	8.265
Lighting	1.585
Total sinking costs per foot	$ 76.757
Timbering	23.701
Ladders	.594
Lagging	1.638
Air brattice	1.708
Total cost	$104.398
General expenses on two shaft basis	6.267
Total cost per foot	$110.665

*This includes the cost of breaking the ground and shoveling, of explosives and of maintenance of rock drills.

Table III.—Cost of Sinking No. 11 Shaft.
(December, 1906; 103 ft., sunk through hard diabase.)

Winding ropes and bell lines	$ 1.783
Surface tramming	5.442
Sinking*	70.471
Pumping	6.611
Hauling	9.376
Lighting	.805
Total sinking costs	$ 94.988
Timbering	34.233
Ladders	.699
Air brattice wall	1.682
Lagging	4.768
Administration and general charges	10.023
Total cost per foot	$136.393

*This includes the cost of breaking the ground and shoveling, of explosives and of maintenance of rock drills.

According to a blue book recently issued by the Royal Commission of Mines of Great Britain, there were, during the period 1896 to 1905, 185 explosions of fire damp or coal dust, resulting in 720 deaths. In 119 of these cases the explosions were caused by the use of unprotected lights, 253 men losing their lives in consequence. During the same period the total number of deaths from all classes of accidents was 10,202. Of these 4,793 fatalities were due to falls of roof or sides and 1,828 to haulage accidents.

Data on the Steam Shovel and Grader Work at the Belle Fourche Dam.

On Jan. 22 the Secretary of the Interior suspended the contract with Orman & Crook of Pueblo, Colo, for the construction and completion of the Belle Fourche dam and distribution canals, Belle Fourche, S. Dak. The contract was entered into Nov. 14, 1905, the total estimated amount being $1,003,299. A complete report of the work done in placing material in the dam by Orman & Crook during the years 1906 and 1907 has been compiled by W. W. Patch and submitted to the chief engineer of the United States Reclamation Service. This report, according to the Monthly Bulletin of the Service, shows that there have been placed 504,000 cu. yds. of earth, 305,000 of which were excavated with steam shovels and transported with locomotives and cars, and 199,000 of which were excavated with elevating graders and transported with dump wagons and teams.

The steam shovel equipment consisted of one 75-ton Vulcan steam shovel during 1906 and two 75-ton Vulcan shovels during 1907. The transporting outfit consisted of 18-ton Davenport dinkey engines each equipped with ten 4-cu. yd. "Western" dump cars. The average haul during 1906 was one mile against a maximum grade of 2 per cent, while that of 1907 was down grade for the same distance with a maximum grade of 4 per cent. The spreading of material on the dam was done with 4-horse buck scrapers, the leveling with 6-horse road levelers, the sprinkling with two lines of 2-in. pipe and hose and the rolling with a 32-H. P. 21-ton traction engine.

The grader outfit consisted of elevating graders of standard size drawn either by 16 horses or by 32-H. P. 20-ton traction engines. The transporting was done by means of 3-horse "Aurora" dump wagons with a capacity of about 1.5 cu. yds., the average haul being about 1,300 ft. The leveling, sprinkling and compacting were done with the same equipment as was used for the steam shovel work.

Common labor cost from $2.25 to $2.50 per man per 10-hour day; horse hire, $1.15 per horse per day, and coal, $10.50 per ton delivered on the work. The unit cost given includes all local general expenses, plant depreciation, repairs and supplies in addition to labor cost. The general expenses amounted to about 3.3 cts. per cubic yard for the steam shovel work and about 2.2 cts. for the grader work.

The average unit cost per cubic yard for the whole period for the steam shovel work was $0.398 per cubic yard, the daily average output being 951 cubic yards per shovel per 10-hour day. The average unit cost for the grader work was $0.266 per cubic yard, the average daily output being 556 cu. yds. per grader per 10-hour day.

Further data regarding this dam were given on page 111 of the Feb. 19 issue of Engineering-Contracting, in the article on the Ashokan Dam Controversy.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Report of the Canadian Government Commission on the Quebec Bridge Failure.

The commission appointed to investigate the Quebec bridge failure submitted its report to the Canadian Parliament on March 9. This commission was composed of Mr. Henry Holgate, Civil Enginer, Montreal, P. Q., Mr. John G. G. Kerry, Civil Engineer, Toronto, Ont., and Prof. John Galbraith, Toronto, Ont., and its report gives in detail the studies of the commission and its conclusions. The length of the report permits only the presentation of the conclusions here; they are as follows:

"As a conclusion reached from the evidence, and from our own studies and tests, we are satisfied that the bridge fell because the latticing of the lower floors near the main pier was too weak to carry the stresses to which it was subjected. We also believe that the amount of these lattice stresses is determined by the deviation of the lines of centres of pressure from the axis of the chords and this deviation is largely affected by the conditions at the ends of the chords. We must, therefore, conclude that although the lower chords 9-L and 9-R anchor arm, which in our judgment were the first to fall, failed from weakness of latticing, the stresses that caused the failure were to some extent due to the weak end details of the chords and to the looseness, or absence of the splice plates arising partly from the necessities of the method of erection adopted and partly from a failure to appreciate the delicacy of the joints and the care with which they should be handled and watched during erection. We conclude from the tests that owing to the weakness of the latticing the chords were dangerously weak in the body for the duty they would be called upon to do. We have no evidence to show that they would have actually failed under working conditions had they been axially loaded and not subject to transfer stresses arising from weak ends details and loose connections. We recognize that axial loading is an ideal condition that cannot be practically attained but we do not consider that sufficient effort was in this case made to secure to a reasonable approach to this condition."

The commissioners find that:

(a) The collapse of the Quebec bridge resulted from the failure of the lower chords in the anchor arm near the main pier. The failure of these chords was due to their defective design.

(b) The stresses that caused the failure were not due to abnormal weather conditions or accident, but were such as might be expected in the regular course of erection.

(c) The design of the chords that failed was made by Mr. P. L. Szlapka, the Designing Engineer of the Phoenix Bridge Co.

(d) This design was examined and officially approved by Mr. Theodore Cooper, Consulting Engineer of the Quebec Bridge & Ry. Co.

(e) The failure cannot be attributed directly to any cause other than errors in judgment on the part of these two engineers.

(f) These errors of judgment cannot be attributed either to lack of common professional knowledge, to neglect of duty, or to a desire to economize. The ability of the two engineers was tried in one of the most difficult professional problems of the day, and proved to be insufficient for the task.

(g) We do not consider that the specifications for the work were satisfactory or sufficient, the unit stresses in particular being higher than any established by past practice. The specifications were accepted without protest by all interested.

(h) A grave error was made in assuming the dead load for the calculation at too low a value, and not afterwards revising this assumption. This error was of sufficient magnitude to have required the condemnation of the bridge even if the details of the lower chords had been of sufficient strength because, if the bridge had been completed as designed, the actual stresses would have been considerably greater than those permitted by the specifications. This erroneous assumption was made by Mr. Szlapka and accepted by Mr. Cooper, and tended to hasten the disaster.

(i) We do not believe that the fall of the bridge could have been prevented by any action that might have been taken after August 27, 1907. Any effort to brace or take down the structure would have been impracticable owing to the manifest risk of human life involved.

(j) The loss of life on August 29, 1907, might have been prevented by the exercise of better judgment on the part of those in responsible charge of the work for the Quebec Bridge & Railway Co., and for the Phoenix Bridge Co.

(k) The failure on the part of the Quebec Bridge & Railway Co. to appoint an experienced bridge engineer to the position of chief engineer was a mistake. This resulted in a loose and inefficient supervision of all parts of the work on the part of the Quebec Bridge & Railway Co.

(l) The work done by the Phoenix Bridge Co. in making the detail drawings and in planning and carrying out the erection, and by the Phoenix Iron Co. in fabricating the material was good and the steel used was of good quality. The serious defects were fundamental errors in design.

(m) No one connected with the general designing fully appreciated the magnitude of the work nor the insufficiency of the data upon which they were depending. The special experimental studies and investigations that were required to confirm the judgment of the designers were not made.

(n) The professional knowledge of the present day concerning the action of steel columns under load is not sufficient to enable engineers to economically design such structures as the Quebec bridge. A bridge of the adopted span that will unquestionably be safe can be built, but in the present state of professional knowledge a considerably larger amount of metal would have to be used than might be required if our knowledge were more exact.

(o) The professional record of Mr. Cooper was such that his selection for the authoritative position that he occupied was warranted, and the complete confidence that was placed in his judgment by the officials of the Dominion government, the Quebec Bridge & Railway Co., and the Phoenix Bridge Co. was deserved.

Twelve Letters Commending the American Society of Engineering Contractors.

In answer to the editorials and invitations extended to engineers and contractors to apply for membership in this proposed society, Mr. Gillette has received scores of letters advocating the formation of such an organization. The total number of applications now exceeds 700. It would seem, therefore, that the permanent organization should soon be effected. An application blank can be found on page 32 of the advertising section.

Twelve letters commending the formation of the society follow:

Sir:—Enclosed find my application for membership in the society you propose forming. In addition to this I shall be glad to give my services to committee work so far as my time and present occupation will permit. Trusting that you may be successfull in your efforts in this good cause, I am

Very truly yours,
ALEXANDER HARING,
Professor of Bridge and Railway Engineering, New York University, New York City.

Sir:—Kindly note the attached application for membership in the above mentioned society. Your efforts meet with my full approval, and I would request that I be fully advised in regard to its development. Placing myself and services at your disposal in any way that I can be of assistance to you in this matter, I am

Yours very truly,
I. RUPERT PACKARD,
General Manager for J. T. Finn, Contractor, New York and Altoona, Pa.

Sir:—I shall be very glad to be kept informed as to developments on the subject of the American Society of Engineering Contractors, and trust that definite results will materialize at no distant date. I believe an organization such as this is absolutely necessary in furthering the welfare of the contracting world. I shall be glad to mention the subject to any of my friends who are interested, and hope to be able to add materially to the membership thereby.

Awaiting your further favors, I am,

Yours very truly,
R. LINCOLN MURPHY,
Contracting Engineer St. Louis Expanded Metal Co.

Sir:—Inclosed find my application as a member of the American Society of Engineering Contractors. I should also like to have the firm's name put in, as I think you are taking one of the most valuable steps ever made in the interest of engineers and contractors. Trusting the year 1908 will see your efforts crowned with success, I am

Yours truly,
J. AMES DICKEY, C. E.,
Sec. and Gen. Man. Jas. D. Funk & Co., Inc., Railroad Contractors, Box 167, Covington, Virginia.

Sir:—Replying to your letter of March 6th, in regard to urging some of my contractor friends to join the proposed American Society of Engineering Contractors, I beg to suggest that you send me some blank application forms and I will take pleasure in doing a little missionary work in this vicinity.

I am a strong believer in the systematic and thorough methods of cost analysis and determination advocated by you, and I am convinced that the society proposed by you can be made of greatest benefit to the engineering and contracting interests.

Yours very sincerely,
P. S. FITZGERALD,
Chief Engineer N. P. Pratt Laboratory, Atlanta, Ga.

Sir:—I am interested in your movement towards an "American Society of Engineering Contractors." I realize that there is much to be gained on both sides by such a union and if the field or scope of membership is extended to Canada, would be pleased to enter my name as a provisional member.

Yours truly,
EDW. S. FUCE,
Galt, Ontario, Canada.

Sir:—Inclosed please find my application for membership to American Society of Engineering Contractors. I am exceedingly interested in the formation of such a society, and I will give the movement my best support.

Hoping for the best of success, I am,

Very truly yours,
FRANK A. HERMANS,
Engineer and Contractor, Cleveland, Ohio.

Sir:—I inclose application for charter membership in proposed American Society of Engineering Contractors. I think that it will be a good thing for engineers and contractors to get together and try to formulate specifications that are fair to both sides.

I don't like to have to watch a contractor as if he were a thief unless he proves himself to be such.

Yours respectfully,
GEORGE STORY, C. E.,
City Engineer San Luis Obispo, Cal.

Sir:—I take pleasure in inclosing application for charter membership in the American Society of Engineering Contractors. I am very much interested indeed, in your plan, and most heartily trust it will succeed.

Yours very truly,
J. N. GUNN.
President Gunn, Richards & Co., New York City.

Sir:—Here's to your good health to the new society's good health. May it *soon* be born, live *long* and *prosper*, if you will pardon the paraphrase.

The proposed amalgamation of interests from both sides of the fence should do an immense amount of good. There is at least a goodly field in which to do your missionary work. The writer has worked on both sides of the fence, and he believes he is numbered among those who understand and appreciate your motives.

Faithfully yours,
JOSEPH A. SARGENT,
Manzanillo, Cuba.

Sir:—Herewith inclosed find application form duly filled out. I heartily agree with the idea of the association as set forth and am fully convinced that much good will result, not only to the parties directly concerned, but to the country at large.

Wishing you success in the cause, I remain

Yours sincerely,
C. D. V. FAIRCHILD,
Res. Engr. Grand Trunk Pacific Ry., Fort William, Ontario, Canada.

Sir:—I am engineer for the Atlantic, Gulf & Pacific Co., the largest contracting firm on these islands. The same firm does extensive business in the states.

We have completed the Manila Harbor Improvement, many reinforced contract buildings and bridges. We are building two steel wharves, each 110 by 650 ft., also the new sewer and water systems. This work amounts to 3 or 4 millions (gold).

I join with you most heartily in advancing the good cause which you have started. I will try and convince my friends of your splendid organization. I am

Yours truly,
EDWARD I. CLAWITER,
Manila, P. I.

Methods and Costs; Some Old, Some New.

Making Brick Aqueduct Watertight.—In order to secure water tightness in a brick aqueduct, where it was carried over a 360 ft. masonry bridge, a continuous lining of sheet lead was placed back of the brick. The interior lining of the aqueduct was 8 ins. of brick, and back of this were placed sheets of lead 16 ft. long by 9 ft. wide, weighing 5 lbs. per square foot. The sheets were burned together without the use of solder. Before the lead was placed the bottom and sides of the aqueduct, against which it was to be placed, were smoothly plastered and then painted with asphalt. After the lead sheets were placed they were covered with a third layer of asphalt.

Moving a Tank.—It became necessary to move an iron tank to a position 130 ft. distance, the following methods being employed in the work: A beton foundation was first constructed at the new site, and a dike constructed about the two foundations. The tank was then hermetically sealed and air pumped in by a compressor. Water was next pumped into the diked area from a neighboring canal and the air pressure in the tank regulated as the water rose about it. When the tank floated it was hauled by cables to its new site, and the compressed air gradually released until the tank settled to position. The tank was 82 ft. in diameter, 32 ft. high, weighing 140 metric tons.

Data on Cast-Iron Work.—The total weight of the cast-iron stairway trim, manhole covers, etc., in the U. S. Government Printing Office at Washington, D. C., was 80 tons. The total value in place was $17,700 or $221.25 per ton. The cost of erection was $62.50 per ton. The wages paid per eight-hour day were as follows:

Superintendent	$5.25
Foremen	4.25
Ironworkers	3.45
Helpers	1.60
Smith	2.25

The total weight of the cast-iron frames and baseboard in the building was 743.4 tons of the total contract amounting to $107,800 or $145 per ton. The cost of erection was practically $23 per ton.

Data on Constructing Concrete Pipe.—The following estimates of cost of concrete pipe manufactured by force account on the Shoshone Project are based on the results of five days' work in November, 1907. The figures are given in the Monthly Bulletin of the U. S. Reclamation Service. The cost of cement was $3.05 per barrel, of sand about $1.40 per cu. yd., and of labor $5 per day for one foreman, $3 per day each for two men and $2.75 per day each for two men. Plant depreciation and administrative expenses are not included in the unit costs given. The concrete was made of 1 part cement and 3 parts sand. The size and the thickness of the pipe, the weight and the unit cost per linear foot thereof and the number of linear feet manufactured in the five days are tabulated below.

Diam. Ins.	Thick. Ins.	Wt. per lin. ft. Lbs.	No. ft. made.	Cost per ft.
12	1½	56	141	$0.25
18	1¾	94	248	.37
24	2	143	56	.57
36	3	366	54	1.15

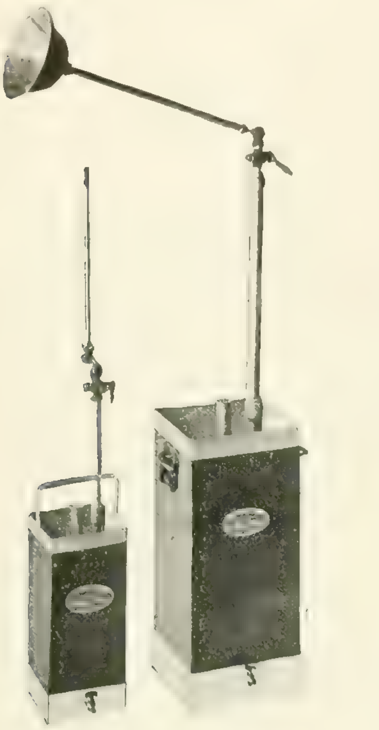
Underdraining a Basement.—In order to make dry the basement of a new building it was necessary to lower the ground water from 4 to 7 ft. The situation was complicated somewhat by the fact that there were a number of elevator pits in the basement, the pits being about 4 ft. deep. It was finally decided to run one large drain to the north and west of all elevator pits and carry the water into a sewer. The idea was that the drain would intercept the ground water and carry it to the sewer, and that this would lower the ground water at least 4 ft. over all that portion of the site south and east of the drain, and establish a new gradient for the water surface for some distance to the north and west. The main drain was about 600 ft. long and had a fall of a little over 2 ft. in this distance. It was made of 12-in. terra cotta pipe. There were also some 8-in. branches. The line was laid with open joints and surrounded with broken stone, rather coarse next to the pipe, but quite fine at some distance from it. In addition most of the pits were covered with burlap to prevent silting up as far as possible. Two manholes were provided.

Laying Submerged Main.—A 15-in. watermain was laid in a dredged trench under a river having a depth of 9 ft. from a heavy cableway strung across the stream. The width of the crossing was about 100 ft., and eight 12-ft. lengths of hub and spigot cast iron pipe, with a wrought-iron hoop shrunk on at the sockets, were used. The pipe weighed 1,850 lbs. per length. The cableway was anchored to two piles on each bank of the river, with a third pile at each anchorage to act as a guide. Five ball and socket joints were used in laying the pipe, alternate joints being made with ball and socket. Two lengths of pipe were put together and a lead joint made between them, half of a ball and socket joint being attached to each end of this two-length section. The section was then hauled across the river by chains rove in blocks on the cableway and lowered nearly to position on the bottom of the river between two barges, placed 8 ft. apart one above and one below the trench, the weight of the section being transferred to these barges. Another two-length section was then made, hauled across the stream on the cableway, and its weight transferred to the barges after the ball and socket joint between the two sections had been made. The third two-length section was then run out on the cableway and suspended, while the fourth two-length section was held on the bank by means of a derrick. The trench was then cleaned out and the eight jointed lengths lowered simultaneously with chains in the blocks from which they were supported. One of the sections was held above the water by the derrick and the other by the cableway until connections could be made with the pipe line on each side of the river.

Securing Average Sample of Garbage.—Studies of the garbage and refuse disposal situation at Milwaukee, Wis., have recently been made by Mr. Rudolph Hering, Consulting Engineer, New York. In connection with these studies tests were made to ascertain the composition and calorific power of the garbage. These tests were made by Prof. R. E. W. Sommer, of Milwaukee, the methods employed by him in securing an average sample of garbage being described in his report as follows: In order to obtain an average sample, the city was divided into five districts, according to the wealth of the population. It was ascertained how many team loads are collected during the same length of time (one month) in each of these five districts. When the teams arrived, Sept. 9, 1907, there were taken as many unit measures of each of the five districts as the district gave wagons within the same time. The garbage was poured upon a sloping hard floor and well mixed with a spade. In order to determine the amount of liquid which is pressed out by the weight of the garbage, a weighed quantity of the mixed garbage was filled into a barrel having a double perforated bottom, and allowed to stand for 24 hours, and the liquid which drained off was weighed. The large quantity of mixed garbage was piled up and quartered down, just as miners do in order to obtain an average sample of ore. After each quartering, the garbage was comminuted with knives, and the quartering and comminution continued until 25 lbs. of garbage were obtained. The liquid pressed out by these processes ran down the sloping floor and was collected, measured, and each time calculated in the right proportion. The remaining 25 lbs. of comminuted wet garbage were brought to the chemical laboratory. Here the quartering was continued until about 2 lbs. were obtained. The approximate 2 lbs. were accurately weighed and heated in a water bath for some days, until they appeared dry, and the drying process continued in a drying oven at 105° C, until constant weight. The loss of weight plus the weight of the liquid (proportionately calculated for 2 lbs.) which was squeezed out by the process of comminution gave the total amount of water. The dry garbage was poured in an iron mortar and gave a coarse, brownish-black powder, somewhat resembling ground coffee. The chemical analysis was made with this powder.

A Light for Contract Work.

We illustrate herewith the Milburn acetylene light for use on contract work. Acetylene is a gas generated from carbide of calcium and water, one pound of carbide yielding 5 cu. ft. of gas having three times the illuminating power of ordinary coal gas. Calcium carbide can be purchased almost anywhere, and at the usual price, it costs less than 15 cts. for 10 hours per 1,000 candlepower developed in the Milburn Light. A No. 3-Z size light measures 12 ins. square by 36 ins. high, weighs only 80 lbs., and develops 5,000 candlepower at a cost of 60 to 75 cts. per night. The gas is piped from the gas generator to the burner. The burner may be mounted on the crane of a steam shovel, so as to throw a powerful light on the face of the excavation. The light is unaffected by vibration or by the weather. Contractors' lights are made in many sizes from 50 candlepower up. The manufacturers are the Alexander Milburn Co., 507 W. Lombard street, Baltimore, Md.



Milburn Acetylene Light.

The value of machinery and plant installed in the fiscal year 1906-7, in the mines in the Transvaal, increased by about $6,500,000 in the gold mining and allied concerns, by $85,000 in the coal mining industry, and by $800,000 in industrial concerns. Among the chief items for new plant during the year were: Steam engines for winding, $400,000; steam engines for compressors (including compressors), $275,000; electric generators and engines, $250,000; belt conveyors and elevators, $140,000; reduction plant, $290,000; treatment plant, $315,000.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0621. **Rubberhide Boots.**—Rubberhide Co., Boston, Mass.

These pamphlets describe and state the wearing qualities, cost, etc., of a special rubber boot with leather sole. Guarantee is made that one pair of these boots will outwear two pairs of ordinary best quality all-rubber boots. The boots are made in all sizes and styles for contractors, sportsmen, etc.

No. 0622. **Steam Boilers.**—Minneapolis Steel & Machinery Co., Minneapolis, Minn.

This 46-page pamphlet gives illustrations, dimensions and general catalog information of the various types and styles of boilers made by the company named.

No. 0623. **Water Towers and Stand Pipes.**—Des Moines Bridge & Iron Works, Des Moines, Iowa.

This company designs and manufactures an extensive line of water towers, stand pipes, railroad water towers, etc., and a number of these structures are illustrated and described in this 52-page pamphlet. Tables of tank capacities, horsepower for raising water, hose streams, friction in pipes, etc., of use to engineers are given.

No. 0624. **Artificial Stone.**—National Stone Manufacturing Co., Minneapolis, Minn.

This company manufactures concrete blocks or artificial stone by a modification of the sand mold process which is claimed to do away with crazing or surface cracks. The pamphlet describes briefly the process of manufacture and its advantages, shows pictures of wall and ornamental blocks and gives views of a number of interesting artificial stone buildings and other structures.

No. 0625. **Gasoline Engines.**—Waterous Engine Works Co., St. Paul, Minn.

This company makes a complete line of gasoline engines for general power purposes and for pumping and also portable and fire engines. This 32-page pamphlet illustrates and describes these machines in some detail and give the usual catalog information. Particular stress is laid upon the workmanship of these engines.

No. 0626. **Quarried Stone.**—Kettle River Quarries Co., Minneapolis, Minn.

Kettle River sandstone is so familiar to builders and contractors that it hardly needs mention. This pamphlet gives, however, a very interesting description of these quarries and an account of their development and of the methods of quarrying practiced which will be of interest to everyone.

No. 0627. **Well Drilling Machinery.**—R. R. Howell & Co., Minneapolis, Minn.

This 96-page catalog illustrates a general line of mill and farm machinery and describes in detail a special line of well drilling machinery. The several types of machines are fully described, tests of tools and appliances are given, and full directions are given for operating each outfit.

No. 0628. **Turbines.**—Barnard & Leas Mfg. Co., Moline, Ill.

The turbine which is considered in this pamphlet is the Moline-McCormick turbine. The pamphlet contains 55 pages and is one of the best examples of catalog work in the way of useful information given that we have seen for some time. It is in fact a very complete little manual on turbine practice and can well be in the files of any engineer.

No. 0629. **Gas, Gasoline and Distillate Engines.**—The Root & Vandervoort Engineering Co., East Moline, Ill.

This company makes a full line of internal combustion engines for general power and pumping work and also portable engines. Both vertical and horizontal engines are described in detail, directions for operation are given and several tables of useful information presented. The pamphlet has 64 pages and is a good one.

Personals.

Mr. William H. Adams has been appointed Borough Engineer of Hanover, Pa.

Mr. A. H. Koebig, Consulting Engineer, has removed his offices from 627 H. W. Hellman Bldg., Los Angeles, Cal., to 705-706 Security Bldg., that city.

Mr. John Cloughen has been appointed Commissioner of Public Works of Manhattan Borough, New York City, succeeding Mr. Henry S. Thompson, resigned.

Mr. A. W. Robinson has been commissioned to examine and report upon the possibilities of improving the navigation of the River Niger by dredging and has sailed for Africa.

Mr. C. T. Dike, Superintendent of Construction for the Chicago & Northwestern Ry., at Pierre, S. Dak., has been transferred to a similar position at Belle Fourche, S. Dak.

Mr. Julius M. Dashiell has been appointed Sales Manager of the branch office which the Wisconsin Engine Co., Corliss, Wis., has recently opened in the Candler Bldg., Atlanta, Ga.

Mr. L. M. Grant has been appointed Constructing Engineer in charge of the development of the underground water supply at Spokane, Wash., succeeding Mr. E. C. Wood, resigned.

Messrs. E. R. Howard and C. C. Motz have formed a partnership and have opened offices at No. 80 Arcade, Nashville, Tenn. where they will engage in an architectural and engineering practice.

Mr. E. W. Wiggin has been appointed Superintendent of Bridges and Buildings of the New York, New Haven & Hartford R. R., with headquarters at New Haven, Conn., succeeding Mr. E. E. Pratt, Jr., resigned.

Hugh Bonner, Fire Commissioner of New York City, died Mar. 13, aged 74 years. Mr. Bonner entered the New York Fire Department in 1860 and continued in the service until 1899, when he retired as Chief. He was appointed Fire Commissioner Feb. 10 last.

Mr. Paul Chipman has resigned his position as Engineer with the Canadian White Co., Ltd., of Montreal, Que., and has opened an office in the Dickman Bldg., Evansville, Ind., where he will engage in a general engineering practice.

Henry S. Eveline, contractor, died Feb. 25, at his home in Waterford, N. Y., aged 61 years. Mr. Eveline built the sewer systems at Amsterdam, Waterford, Little Falls, Lansingburg and Onconta, in New York State, and at a number of places in Massachusetts.

Samuel Webber, M. Am. Soc. M. E., one of the best known of the older hydraulic engineers, died recently at his home in Charlestown, N. H. Mr. Webber at one time was connected with the water power developments at Manchester, N. H., and at Holyoke, Mass.

Messrs. Edmund M. Burke and Henry A. Symonds, have entered into a partnership and have opened offices at 8 Beacon St., Boston, Mass., where they will engage in a general engineering practice, making a specialty of sanitary, hydraulic, municipal and gas engineering.

Mr. W. E. Emery has resigned as Engineer of Maintenance of Way of the Chicago & Alton R. R., with headquarters at Kansas City, Mo., and the jurisdiction of Mr. C. G. Delo, Engineer of Maintenance of Way, with headquarters at Bloomington, Ill., has been extended over the entire system.

The New York, New Haven & Hartford R. R., has been divided into six engineering divisions, the division engineers being as follows: New York Division, headquarters Harlem River, N. Y., Mr. H. A. Weaver; Shore Line Division, headquarters New Haven, Conn., Mr. F. H. Ellsworth; Providence Division, headquarters Providence, R. I., Mr. J. S. Browne; Boston-Midland Division, headquarters Boston, Mass., Mr. G. T. Sampson; Old Colony Division, headquarters Taunton, Mass., Mr. J. W. Pearson; Western Division, headquarters New Haven, Conn., Mr. W. T. Spencer.

Mr. R. F. Tucker has relinquished his active participation in the management of Tucker & Vinton to assume the management of the Eastern Department of the American System of Reinforcing which has purchased from Tucker & Vinton its patents covering the manufacture of unit girder frames. The firm of Tucker & Vinton, which is now located in its new offices at the Terminal Bldg., 41st St. and Park Ave., New York City, will in the future devote itself to steel concrete and vault light construction. The American System of Reinforcing will have offices in the Building Trades Bldg., 35 W. 32nd St., New York City.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

*SUBSCRIPTION RATES (Payable in Advance):— **$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*

***$2.50** a year (52 issues) to Dominion of Canada.*

***$3 00** a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

Public Works Commissions Should Be Composed of Engineers............173

CONCRETE SECTION:

Results of Tests of Cement Drain Tiles..............................171
Method of Plastering Concrete Surfaces at Syracuse University Stadium..............................175

EARTH AND ROCK SECTION:

Methods of Grubbing Stumps and Trees..............................176

GENERAL ARTICLES:

Twelve Additional Letters Commending the American Society of Engineering Contractors................179
Method and Cost of Road Treatment with Tar and Oil in Rhode Island..181
An Unclimbable Fence...............183
Meter Box Cover for Sidewalk Setting of Water Meters..............184

METHODS AND COSTS:

Depreciation of Electric Railways—Hand Driven Sheet Piling Work—Data on Painting Railway Bridges..180
CATALOGS WORTH HAVING..............184

Public Works Commissions Should Be Composed of Engineers.

In our issue of Feb. 19, we published, with some comment, an interview with an ex-mayor of Baltimore, regarding the legislating out of office of the sewerage commission of that city, and the appointing of a new commission composed mostly of engineers.

Four years ago Baltimore suffered from a severe fire that nearly destroyed its business section. Steps were immediately taken to rebuild the burnt district, and many needed improvements were started, such as the widening and regrading of streets, the building of extensive piers in the harbor, a complete sanitary sewer system, storm water sewers, school buildings and fire engine houses, street paving, enlarging of public, parks, amounting in the aggregate to about $25,000,000.

There are now bills before the Maryland legislature to spend $5,000,000 on paving in the city, $5,000,000 for additional water supply, and additional sums for other improvements, that will make the total amount appropriated for improvements since 1904 foot up to about $40,000,000.

The expenditure of the major part of this vast sum is in the hands of various commissions appointed by the mayor of the city. The work that the individual commissioners have to do is to pass upon the plans for the different classes of work submitted by the engineers of the different commissions. This and the routine of approving bills are their principal duties.

Judging from the Baltimore daily papers, the present sewerage commissioners are on the grill, the city council having passed resolutions to investigate the work of the commission by a committee of councilmen. This is due to the fact that the estimated cost of $10,000,000 for the sewers will be exceeded, the commission stating, so it is reported, that an additional $4,000,000 will be needed.

Among the ten reasons given for the need of this investigation, by the member of the city council, in introducing his resolutions, were the following:

"First.—The chairman of the commission says the commission simply evolves the policy of the board and carries out the suggestions of its engineer. Why such a commission?

"Fifth.—Men on the commission have had no experience on boards where construction work was involved, which places them at the mercy of the engineer."

This is a state of affairs that will always occur when these public commissions having in charge engineering work are made up of so-called business men. These men may be able business men and of great integrity, but their ignorance of engineering construction puts them entirely at the mercy of incompetent engineers. In New York City the Board of Water Supply recently attempted to shield themselves behind their engineers, stating they had rejected the lowest bid received for building the Ashokan Dam, and accepted one nearly $2,500,000 higher, acting entirely on the advice of their engineers who had stated that the bid of the lowest bidder was below actual cost. A statement they could not afterwards substantiate.

One of these New York commissioners stated that he was not accustomed to making contracts, as it was not one of the duties of a banker. Yet the awarding of a contract is as nearly a business proposition as a man is likely to have presented to him.

All of these things point to but one conclusion, namely, public works commissioners should be composed in whole or in part of engineers.

Baltimore should profit by her own past experience and that of New York, and if the present sewerage commission is legislated out of office, its successors should be appointed from the engineering profession. The already overworked engineers of other departments should not be given the additional duties of sewerage commissioners, but engineers who can devote the major part of their time to this work should be appointed.

The civil engineers of Maryland should see to it that the present bills before their legislature to authorize Baltimore to spend millions on their streets and for additional water supply, should be so amended that the commissions having charge of this work shall be made up of engineers. Failing in this, the attention of the mayor of the city should be called to the matter, and a request made to him for the appointment of engineers as commissioners. Many thousands of dollars can be thus saved to the city.

The excavation of Keno Canal, Klamath Project, was conducted during the latter part of 1907 by the U. S. Reclamation Service by force account. During the last eight months of the year about 68,000 cu. yds. of earth were excavated, of which about 38,000 were of Class 1, 15,000 of Class 2 and 15,000 of Class 3. The excavated material was classified under the classes given in Specifications No. 132. The average unit cost, including plant depreciation and all engineering and administrative expenses, was about $0.30 per cubic yard for Class 1, $0.60 per cubic yard for Class 2 and $1.79 for Class 3. The Monthly Bulletin of the Service states that this excavation was practically all very difficult side hill work, Class 3 being extremely hard to remove and much of the line being covered with huge boulders in large quantities. A considerable portion of the work had to be done by hand.

The Swedish government is making plans for an international forestry exhibition to be held in Stockholm in 1910.

The Communal Council of Milan, Italy, has authorized the expenditure of $2,546,640 for the construction of a hydro-electric installation in the Alpine hills north of the city.

The yearly report of the U. S. Steel Corporation shows that the gross income of the corporation during 1907 amounted to $757,014,768. In 1906 the gross earnings were $696,758,928.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Results of Tests of Cement Drain Tiles.

Throughout the central west where drainage of farm lands is extensively practiced much interest is felt in the possibilities of using drain tile made of cement in place of the familiar burnt clay tile. Cement tile are being made quite extensively and have been used in a number of works, but beyond general statements and claims as to their suitability very little specific information is available regarding them. Recently, however, some tests were made at the laboratories of the Iowa State College by two of the senior students, Mr. M. A. Mills and Mr. Robert Moles, at the instance of Prof. A. Marston, who has reported the results in a paper read before the Iowa Cement Users' Association. We publish the salient features of this paper here:

In the beginning of this investigation it became necessary to devise a method of testing which, while reproducing as nearly as practicable the actual conditions under which the pipe are to be used, would be capable of exact duplication in different laboratories and by different investigators.

As tile and sewer pipe are actually used in the ditch, the bottom of it does not exactly conform to the lower half of the pipe, and there is a tendency for the earth to settle away from the under side at the outer portions, leaving the pipe unsupported there. At the mid-diameter, in a narrow ditch, or with careless tamping, there is also lack of support from the earth filling. The load comes upon the upper half of the pipe from the weight of superincumbent filling, but this will receive some support by friction against the sides of the ditch.

After careful consideration of these conditions, it was decided that the best standard method easily capable of duplication in any laboratory, and which should approximately represent actual service conditions, would be to bend the lower portion of the pipe for one-quarter of the entire circumference in sand, retained firmly in place by a heavy frame work of timber, and to apply the load to the upper portion through a similar bed of sand, extending one-fourth of the entire circumference of the pipe, and all held in place by a heavy frame work of timber. A thickness of cloth or canvas was used to prevent the sand from escaping between the edge of the upper frame work and the pipe. The pressure was applied to the upper surface of the bed of sand and not to the upper frame work. There was no danger, therefore, of concentrated pressure coming upon the pipe through contact with the upper frame.

The tests were made on a 100,000-lb. Transverse Riehle testing machine.

General Plan of Investigation.—As already stated, a number of samples of drain tile were secured from manufacturers as representative of their product, in the case of both cement and clay. The cement tile so obtained ranged from 4 ins. to 12 ins. The clay tile on the other hand ranged from 4 to 24 ins. internal diameter. Besides testing the above samples obtained from manufacturers, it was thought desirable to manufacture some cement tile, so that accurate information would be available as to the proportions of sand and cement and all other features of the manufacture.

A 1—3 mixture was adopted for these tile. The material was of good, coarse sand, containing some small pebbles. The tiles were made in Miracle molds by the ordinary dry process, the details being directed by an experienced tile maker. The work was done in the month of March, in the basement of one of the college buildings which was under construction. The tile were protected against freezing, but were not kept at a very high temperature. They were kept thoroughly sprinkled with water until set hard. The internal diameters of tile manufactured were 12, 18 and 20 ins. respectively.

After making a complete set of tile of the regular thicknesses provided for by the Miracle molds, these molds were remodeled in our shops and a second set of tile manufactured, having about ½ in. greater thickness of shell than the first. Enough tile were made to enable two of each thickness of shell to be broken at the respective

TABLE I.—TESTS OF THE STRENGTH OF 12 TO 20-INCH CEMENT DRAIN TILE.
Made at Ames, by Mills and Moles.

Propor. C.	Propor. S.	Dimensions, ins. L.	Dimensions, ins. D.	Dimensions, ins. T.	Str. load per lin. in. 2 months.	Str. load per lin. in. 11 months.	Remarks.
1	3	24	20	2¼	89	69	Cracked.
1	3	24	20	2¼	73		
1	3	24	20	1¾	68	142	
1	3	24	20	1¾	70	175	1½ in shell
1	3	24	18	2¼	115	315	2 in. shell.
1	3	24	18	2¼	141	299	2 in. shell.
1	3	24	18	1¾	109	221	1½ in. shell.
1	3	24	18	1¾	79	81	Cracked.
1	3	24	12	2	116	365	
1	3	24	12	2	155	470	2¼ in. shell.
1	3	24	12	1½	135	181	
1	3	24	12	1½	99	218	
		24	12	1½	95		
		24	12	1½	125		
		24	12	1½	58		Under tamped.

TABLE II.—TESTS OF THE STRENGTH OF 10 TO 20-INCH CLAY DRAIN TILE.

Made at	Degree of Fusion.	Dimensions, ins. L.	Dimensions, ins. D.	Dimensions, ins. T.	Load, lin. ft.	Remarks.
Des Moines	Vitrified	24	24	2⅛	318	
Des Moines	Vitrified	24	18½	1¼	212	
Des Moines	Vitrified	24	18½	1¼	187	
Mason City	Semi-vitrified	27	18½	1⅛	96	Badlv Checked
Mason City	Semi-vitrified	27	17½	1	89	Checked
Mason City	Semi-vitrified	27	15	1	64	Badly Checked
Mason City	Semi-vitrified	27	15	1	103	
Des Moines	Vitrified	12	12	⅞	168	
Des Moines	Vitrified	12	12	⅞	117	
Mason City	Semi-vitrified	12	12	⅞	158	
Storm Lake	Soft burned	12	12	⅞	151	
Storm Lake	Soft burned	12	10	1	98	

TABLE III.—TESTS OF THE STRENGTH OF 4 TO 12-INCH CEMENT DRAIN TILE.

Made at	Proper C.	Proper S.	Dimensions, ins. L.	Dimensions, ins. D.	Dimensions, ins. T.	Age.	Load per. lin. in.
Sherburn	1	5	12	12	1		98
Sherburn	1	5	12	12	1		115
Emmettsburg	1	4	12	10	⅞	6 months	106
Sherburn	1	4	12	8	¾		97
Emmettsburg	1	4	12	8	¾	6 months	71
Emmettsburg	1	4	12	8	¾		74
Sherburn	1	5	12	7	¾		99
	1	5	12	7	¾		177
	1	6	12	6	⅝		
	1	5	12	6	⅝		66
	1	5	12	6	⅝		73
	1	3	12	5	⅝		97
	1	5	12	5	⅝		82
	1	5	12	4	⅝		98
	1	5	12	4	⅝		80

TABLE IV TESTS OF THE STRENGTH OF 4 TO 10-INCH DRAIN TILE (CLAY).

Made at	Degree of fusion.	Dimensions, ins L.	Dimensions, ins D.	Dimensions, ins T.	Load per. lin. in.
Mason City	Semi-vitrified	12	10	⅞	117
Mason City	Semi-vitrified	12	10	⅞	127
Mason City	Semi-vitrified	12	10	¾	102
Mason Citv	Semi-vitrified	12	8	¾	134
Storm Lake	Soft burned	12	8	¾	98
Storm Lake	Soft burned	12	8	¾	103
Storm Lake	Soft burned	12	8	¾	118
Storm Lake	Soft burned	12	6	¾	125
Storm Lake	Soft burned	12	6	¾	106
Des Moines	Vitrified	12	6	⅝	160
Des Moines	Vitrified	12	6	⅝	150
Mason City	Semi-vitrified	12	6	⅝	90
Mason City	Semi-vitrified	12	6	⅝	128
Mason City	Semi-vitrified	12	6	½	123
Mason City	Semi-vitrified	12	4	½	141

ages of two months, eleven months, two years and three years. Only the two months and eleven months tests have been made as yet.

Results of Tests.—The results of the tests are shown in Tables I to IV herewith. In these tables C means cement, L length, S sand, D diameter and T thickness.

DISCUSSION OF RESULTS.

Increase in Strength of Cement Tile with Age.—In attempting to draw conclusions from the above results, it should be remembered that tests of clay and cement materials show large variation due to unavoidable differences in manufacture, and hence not too much reliance should be placed upon the results of so small a number of tests as are given in the above tables. Perhaps the most striking feature in connection with these tests is the great increase of strength from two months to eleven months in the age of the cement tile manufactured at the college. In this connection it should be remembered that the weather was cool during the first two months these were cured. The increase in strength is shown in Table V following:

TABLE V.—PER CENT OF INCREASE IN STRENGTH OF CEMENT DRAIN TILE BETWEEN THE AGE OF TWO MONTHS AND ELEVEN MONTHS.

Diameter.	Per cent of increase.
20 in. thin	130
18 in. thick	140
18 in. thin	136
12 in. thick	205
12 in. thin	71

One good quality of cement drain tile is that they continue to increase in strength after first manufactured. Unfortunately, however, the heaviest pressures come upon them soon after they are laid. It would not seem wise, therefore, to use cement tile very soon after manufacture.

Effect of Thickness of Shell Upon Strength.—Theoretically the strength of cement drain tile per lineal inch should be in proportion to the square of the thickness of the shell. In these tests this law is obscured, possibly by variations of the strength due to other causes than thickness. The relation of strength to thickness is shown in Table VI herewith:

TABLE VI—EFFECT OF THICKNESS OF SHELL ON BREAKING STRENGTH.

Diameter in ins..	12 ins.		18 ins.		102 ins.	
Age...........	2 mos.	11 mos.	2 mos.	11 mos.	2 mos.	11 mos.
Thickness of shells, ins.....	2 1½	2¼ 1½	2½ 1¾	2 1½	2¼ 1¾	
Ratio of thicknesses . . .	1.33	1.42	1.20	1.33	1.29	
Ratio of squares of thicknesses::	1.78	2.01	1.65	1.38	1.18	
Ratio of strengths......	1.17	2.08	1.36	1.38	1.18	

It is altogether probable that in an extensive series of tests the strength would be found more nearly proportionate to the square of the thickness of the shell. At present the question of the proper thickness of drain tile is in a very unsatisfactory condition. The writer feels obliged to offer criticism of cement tile molds as ordinarily made, because so little effort seems to have been taken to proportion the thickness to the actual necessity.

It has already been stated that theoretically the strength of tiles of the same diameter will be in proportion to the square of the thickness. With the same load the strength theoretically should be inversely proportional to the diameter for equal thickness. Neglecting the friction of the trench filling against the sides of the ditch, the load would be approximately proportional to the diameter. Putting these factors together, we would find some cause to believe that thickness of drain tile should be proportional to the diameter of the pipe, for equal resistance to the pressures coming upon them. This whole question should be made a matter of actual scientific tests to determine the actual pressure which may be brought to bear upon drain tile, and the strength of the tile of different thicknesses of diameter with different proportions of cement. There should then be adopted some standard specifications for thickness to which all manufacturers should conform. At present accurate data does not exist for preparing such standard specifications.

It seems probable that the standard thicknesses should follow the general law which has been found satisfactory for clay tile, but with a percentage of increase over those adopted for clay tile sufficient to provide for the less strength of the material.

Comparison of the Strength of Cement and Clay Tile.—Our experience in making this series of tests has convinced us of the very unsatisfactory character of the results made on samples of cement tile collected at random here and there around the state as a basis for scientific investigation. While such tests may be useful to get some idea of the character of the tile now being made, they may vary greatly owing to mistakes or carelessness in manufacture which can not be made a matter of record. For example, in comparing the different proportions of sand and cement reported in table III we cannot be sure that the small portions of mortar out of which the individual tile happened to be made were really of the proportions indicated, nor can we be sure that the tile received the same treatment in curing.

Hence the only comparison between cement and clay drain tile which we feel warranted in making at this time is in the case of the cement tile manufactured by ourselves. A comparison of the tests of these tile with those of corresponding diameters of clay tile is hereby given in Table VII:

TABLE VII.—COMPARATIVE AVERAGE STRENGTH OF CEMENT AND CLAY DRAIN TILE.

Internal diam., ins.	Age 2 months			Age 11 months			Clay tile.		
	Thk. No.	Thk. In	Str. lbs Lin. in	Thk. No.	Thk. In	Str. lbs Lin. in	Thk. No.	Thk. In	Str. lbs Lin. in
24							1	2⅛	318
20	2	2¼	81						
20	2	1¾	69	2	1⅝	159			
18	2	2¼	128	2	2	307			
18	2	1¾	94	1	1½	222	2	1¼	200
15							1	1	103
12	2	2	137	2	2⅛	417	3	1⅛	158
12	2	1½	117	2	2½	200	2	⅞	141

A study of this table will convince any one that it is feasible to make cement drain tile which will attain all necessary strength and which will compare very favorably in this respect with clay tile. However, no one should place too much dependence on the small number of tests represented in Table VII.

Conclusion.—In conclusion, the writer may present the urgent need for an extensive and systematic series of scientific tests of cement drain tile. There should be a series of tests to determine the actual pressures coming upon tile under working conditions; also different percentages of cement should be tried in the manufacture, and the strength of the resulting product determined. The different thicknesses of shell should be studied in the same way, and different methods of manufacture. The effect of age is another important feature. Finally, as a result of such tests and of practical experience, a standard set of specifications for the manufacture of cement drain tile should be prepared and adopted.

Method of Plastering Concrete Surfaces at Syracuse University Stadium.

The new stadium at Syracuse University constructed of reinforced concrete has its exposed surfaces finished with plaster applied as follows: At frequent intervals wire nails were driven into the forms on the inside so that the pointed ends projected about 2 ins. outside of the rough concrete after the forms were removed. Before applying the plaster a small iron nut was put on each projecting nail. Wire lath was then spread against the surface, and fastened by bending the projecting ends of the nails over it with a hammer. The nuts served to keep the lath about ¼-in. away from the concrete. The wire lath used was 2½ mesh No. 20 wire; the nails were about 4 ins. long, and the nuts were either square or hexagonal and about ¼-in. high. The plaster was put on in two coats of a total thickness of from ¾ in. to 2 ins. The scratch coat was composed of 1 cement, ¾ lime and 3 sand mortar and the finishing coat 3/16 in. thick of 1-1¾ cement and sand mortar; the sand was white beach sand. To carry the plaster to the desired lines iron templets were placed at intervals and the plastering finished to them. Before the finishing coat had commenced hardening the templets were pulled out and the voids filled. The second coat of plastering was put on when the scratch coat commenced hardening, and was troweled to a smooth finish. While the plastering was being done the work was protected from the sun by wooden sheds which were erected over it and moved according to the progress. During the hardening of the plaster it was covered with burlap on top of which was a layer of sand kept constantly wet.

Wood paving was used in London in 1839.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Methods of Grubbing Stumps and Trees.

From time to time we have published articles on clearing and grubbing, giving some costs on these subjects, but in most cases more detailed description has been given of the clearing than of the grubbing. These articles can be found in Engineering-Contracting for Oct. 17, 1907; Feb. 27, 1907; Dec. 25, 1907. In this article we discuss at some length the methods of grubbing.

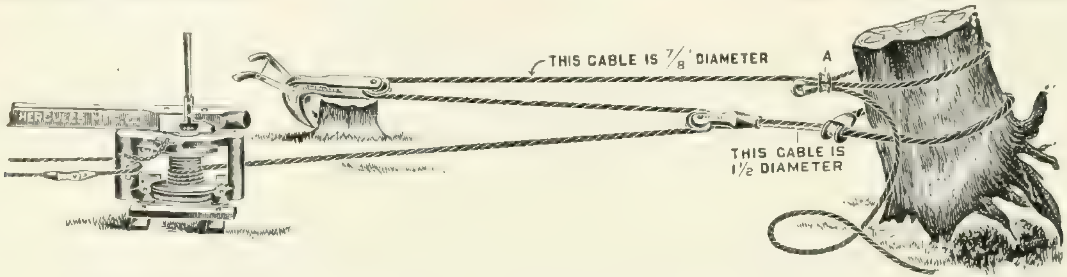


Fig. 1.—Sketch Showing Small Base Puller with Anchor Line, Also "Take Up" Being Used at Stump.

There are four methods of grubbing: (1) Grubbing by hand; (2) by burning; (3) by blasting; (4) by stump pullers.

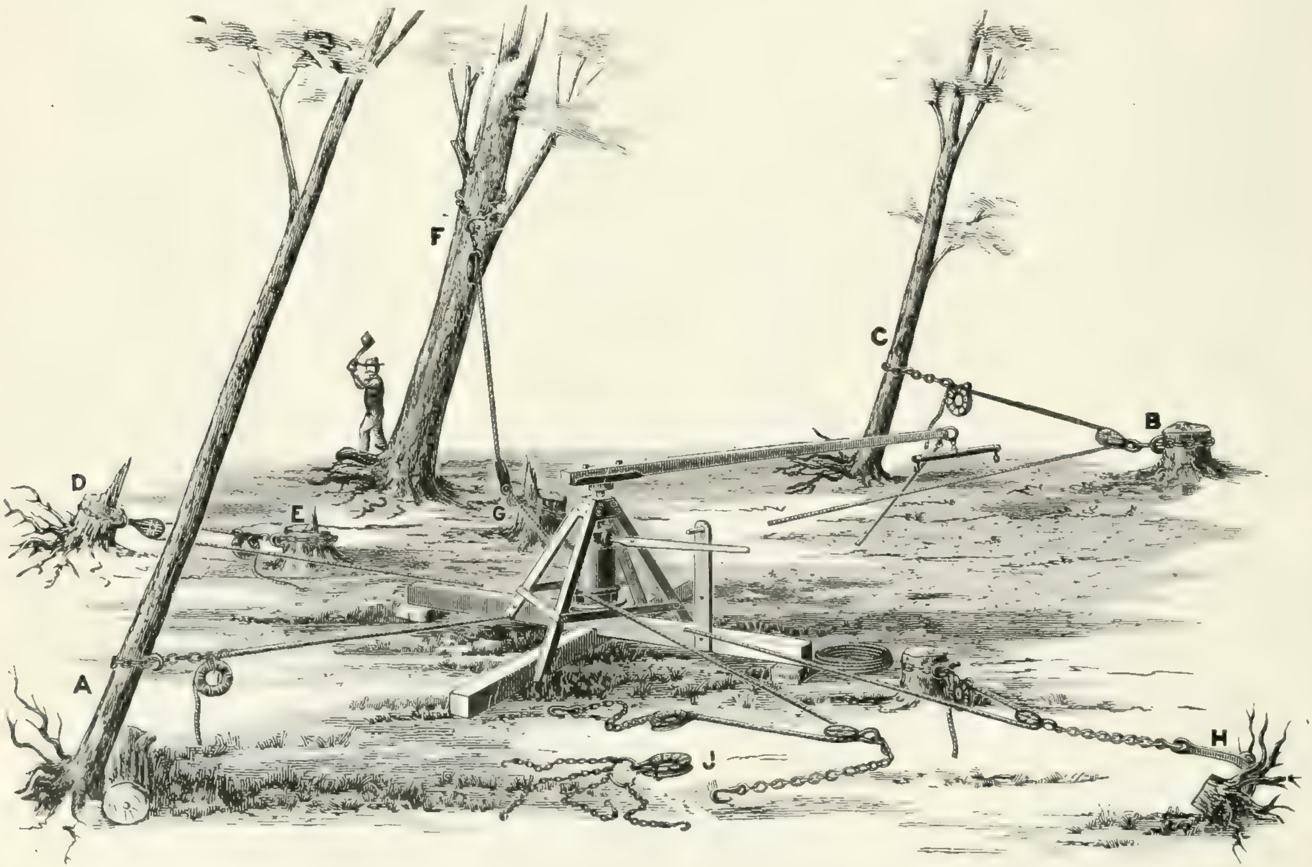


Fig. 2.—Sketch Showing Large Base Puller and Various Uses to Which a Stump Puller Can Be Put.

(1) When stumps are grubbed by hand, the tools to be used are a long cutter mattock, an axe, and a round pointed shovel. A long heavy lever should also be cut in the woods to be used in prying up stumps, after they have been partially loosened. This will be found a great help. Two men should always work on one stump, as their pace will be faster than when a man works alone, and they will do more efficient work with a lever.

When grubbing is done by hand, and the stumps can remain in the ground throughout the winter, in cold climates, much work can be saved by digging around the stumps in the fall and cutting of a few of the main roots. The frost then gets down under the stumps through the excavation made, and this heaves the stump partly out of the ground, making the rest of the work comparatively easy in the spring. Old stumps can be taken out in this way easier than green ones from which the trees have just been cut. In clearing up land and when able to let the stumps remain in the ground for several seasons, by doing a little work around the stump each autumn farmers can let frost heave the majority of the stumps almost entirely out of the ground, in two or three years.

(2) The burning of stumps has but a limited use, yet at times money can be saved with this method. Old hollow stumps are easily burnt, but green stumps are more difficult to burn. In burning stumps, the ground should be dug away from the stumps somewhat, and the larger roots should be partly exposed. Then brush and logs should be piled around and over the stump and set afire. With some renewal of logs, the fire can be kept going until the entire stump is burnt up as well as the heavier parts of the large roots. This method can be used when the logs

and brush cut in clearing have to be burnt up, but only a few cases, as with rotten hollow stumps that are difficult either to blast or pull, will it pay to cut wood to assist in burning stumps. When stumps have to be burnt up after they are taken out of the ground, it is always well to split them up, as it will cost much less to burn them. The cheapest way to split most stumps is to bore a hole down the center with a large size ship auger and place in this hole a stick of dynamite. Exploding the cartridge will generally split the stump in several pieces.

(3) Blasting stumps when done properly is an economical method of grubbing, but the writer believes that on most railroad work money is wasted by excessive charges of explosives, and by the lack of knowledge in placing the charges. The tools used in blasting stumps should be an auger with a long handle for boring into wood, also an auger for boring into the ground, several steel churn drills for drilling holes, a scoop for enlarging the bottom of the hole, and some wooden tamping rods.

In blasting stumps, dynamite, Judson powder and black blasting powder can be used, but judgment must be exercised in their selection. For small stumps, and for stumps in sandy or light soils, dynamite should be used exclusively, but for larger stumps and in heavy soils, Judson or Contractor's powder will be found more economical. For large stumps, the hole can be sprung with a small charge of dynamite, and then a good charge of Judson powder can be used. For stump blasting, Judson powder is the most economical except for small stumps or extremely large ones. For the largest stumps, more than one hole can be made under the stump, each hole sprung, and loaded with black powder, and, by firing with a battery, it is possible to tear out the entire stump and most of the large roots with one blast. To shoot small stumps with black powder is more expensive than with either dynamite or Judson. For Judson and black powder, a small piece of dynamite is generally used to detonate the charge, but two different explosives should not be charged in the same hole.

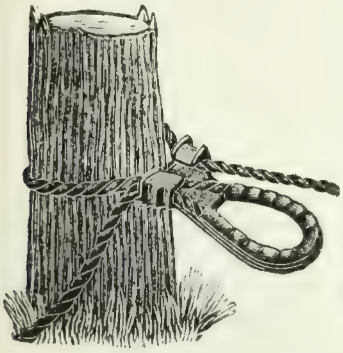


Fig. 3.

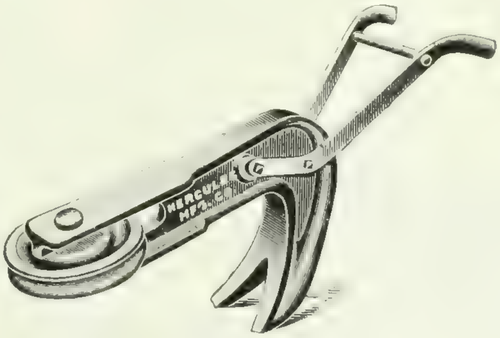


Fig. 4.

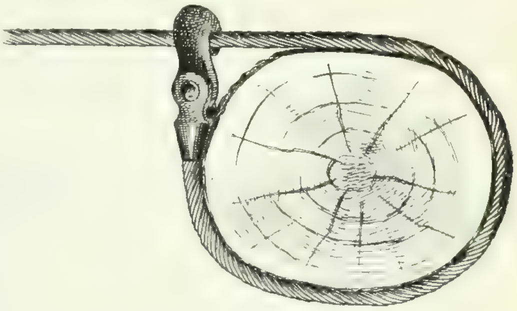


Fig. 5.

In locating the charge under the stump, a careful survey should be made of the soil, the shape of the stump, and the directino the largest roots go down into the ground. The charge or charges should be placed where the stump is most securely fastened. In light soils put the charge close up under the stump, and with very light soils a flat rock placed in the bottom of the hole and the hole well tamped after placing the charge between the rock and the stump will give better results. In heavy soils the charge should be placed well down among the rocks.

For most stumps one charge placed well under the stump will give satisfactory results, but for very large spreading stumps several charges should be placed under them. It is seldom that good blasting can be done by boring into the stump, as a rule this only breaks it up, but in blasting stumps in marshy ground, savannahs and bogs, the charge must be placed in the wood. Then a number of small charges are placed in a series of holes bored down to the roots of the stump and shot with a battery.

In stump blasting always consolidate the charge rather than spread it out over some area. The concentrated charge will give a much more effective blast. It is for enlarging the hole, and thus keeping the charge in one mass that the scoop will be needed. When stumps have a large tap root, it is advisable to bore into this root and after reaming out the hole, place the charge in it. This will cut off the root and blow out the stump. To blast in any other manner will only split it up.

When stumps have been blasted, but not blown out, being only split, they can readily be burned up by piling wood around them and setting fire to it. Care should be taken not to set fire to stumps under which charges had misfired. Under such stumps a new charge should be placed near enough to the old to explode both.

(4) The grubbing of stumps with a stump puller is, like blasting, an economical method. A stump puller is simply a winch operated by horse power, that pulls the stump, roots and all from the ground. The operation is extremely simple. The machine is set up at a convenient level spot, and wire cables are fastened to the stump to be pulled. The team is started and as they circle around the puller, the cable is wound up on the drum of the machine, causing such a gradual and powerful strain on the stump that it is dislodged from the ground.

There are a number of firms manufacturing stump pullers and each make varies but little from the others in general design. Most manufacturers are now making groved drums on their machines, as this prevents the steel rope from cutting against itself as it winds on the drum, and from being pressed out of shape. Those pullers made of steel instead of iron are much stronger for the same weight, which is an advantage when the machine has to be moved frequently.

Some of the pullers are mounted on small bases, and these generally have to be anchored by means of a cable or chain to an adjoining stump or tree, see Fig. 1. Some of these machines have a large hook on the side to be used in anchoring.

Fig. 2 shows a machine with a large base. This machine is not ordinarily anchored, but, if much work is to be done at one place, and especially if the stumps are large green ones, it is well to anchor both styles of bases, by driving large forked stubs in the ground on all sides of the puller, thus holding it to the ground and in place.

The lever to which the horses are attached can, where it is fastened to the machine, be extended beyond it, and, where the work is hard, this end can have a weight fastened to it, thereby assisting the horses, as this extra weight serves as a counter balance. As the horses walk around the machine they have to step over the cable that is pulling the stump, and it is found at times that this interferes with the horses when there is a great strain on the cable. To overcome this, some stump pullers have been made to be thrown out of gear and back into gear while there is a strain on the cable. This allows the horses to step over the cable without danger, and also admits of a stump being pulled where the horses cannot circle clear around the machine, but must stay on one side only. The machine can be thrown out of gear and the horses backed, to make a new pull.

Stumps are pulled either by a direct pull, see Fig. 2, or by a double pull or power. Naturally the work is a little slower with the double pull than with the direct pull, yet it sometimes pays to use it in preference to moving the machine so frequently, as would have to be done with a short rope and a direct pull. It is seldom advisable to use a short cable on a machine. One from 150 to 200 ft. is much better. So much more work can be done from one "set up" of the machine with such a length of rope. For instance, in clearing large areas of land, a cable 50 ft. long will clear less than ¼ acre, a 75 ft. cable clears about ½ acre, a 100 ft. cable clears less than ¾ of an acre, a 150 ft. cable will clear 1½ acres, while a 200 ft. cable will clear nearly 3 acres, from one set up.

There are several methods of taking up the extra length of cable. One is shown in Fig. 1, where it is made into a double pull. Some machines have a hand winder on the drum to take in the slack before starting the horses. This is a good attachment to any machine, as there is always some slack to be taken up, and it is done quicker by hand than by the team. Another method is to have a "take up," shown in Fig. 3. This allows the pulling cable to be hooked around any stump at any place on the cable.

The sizes of stump pullers are governed by the pull they exert, which in turn is controlled by the size of the steel cable used on the machine. Cables from ½ in. to 1½ ins. are used; the smaller ones for machines to be operated by one horse, while on the larger ones four horses are sometimes used. Each manufacturer varies his machine as to sizes and numbers designating them, and the weights likewise vary considerably, as catalog weights include equipment sent with puller, which alone, due to length of rope included, can make a variation in weight of over 100 lbs. Generally there are about eight different sizes and weights of machine made. The two smallest sizes will weigh from 200 to 400 lbs. The two medium sizes will weigh from 400 to 700 lbs. The light patterns of the large sizes will weigh from 700 to 1,000 lbs., while the heavy patterns of the large sizes weigh from 1,200 to 1,500 lbs., but some extra heavy machines weigh as much as a ton.

A great deal of work done by a stump puller is illustrated in Fig. 2. "A" represents the tree being pulled by direct pull; the chunk at the root of the tree forms a fulcrum over which to lift the roots running toward the machine. This is often a great help, as the hardest pull sometimes comes when the tree is down. "B" and "C" represent a tree standing so near the machine that, if pulled toward the machine, it would fall upon the horses. The stump at "B" stands beyond the tree, so that the tree is thrown away from the puller. In this manner a tree may be thrown in any direction. Likewise stumps standing inside the circle in which the horse travels may be pulled in this manner. "D" and "E" represent a large stump being pulled by a double pull or power, "E" being the anchor stump.

"F" and "G" represent a large tree being pulled by single power by hitching high, the rope going through a pulley or snatch block attached to the stump "G," thus allowing the horses to step over the rope. At "H" is shown a stump hook pulling out a low small stump, and "J" shows a coupler with four small chains attached for rapid work, pulling four small stumps or roots at a single pull.

There are numerous devices meant to be used with stump pullers. The one shown at "J" in Fig. 2 is manufactured by the Milne Manufacturing Co. of Monmouth, Ill., to which we are indebted for the cut.

The tool shown in Fig. 4 is a grub plow made by the Hercules Manufacturing Co. of Centerville, Ia., which makes the puller illustrated in Fig. 1. This grub plow is not only useful in pulling small stumps but it can be used for grubbing up large and small roots, being propelled by the puller. This plow will save much money in grubbing for elevating grader work. There are other styles and makes of root hooks, mostly meant for roots that grow above the ground, as the palmetto does.

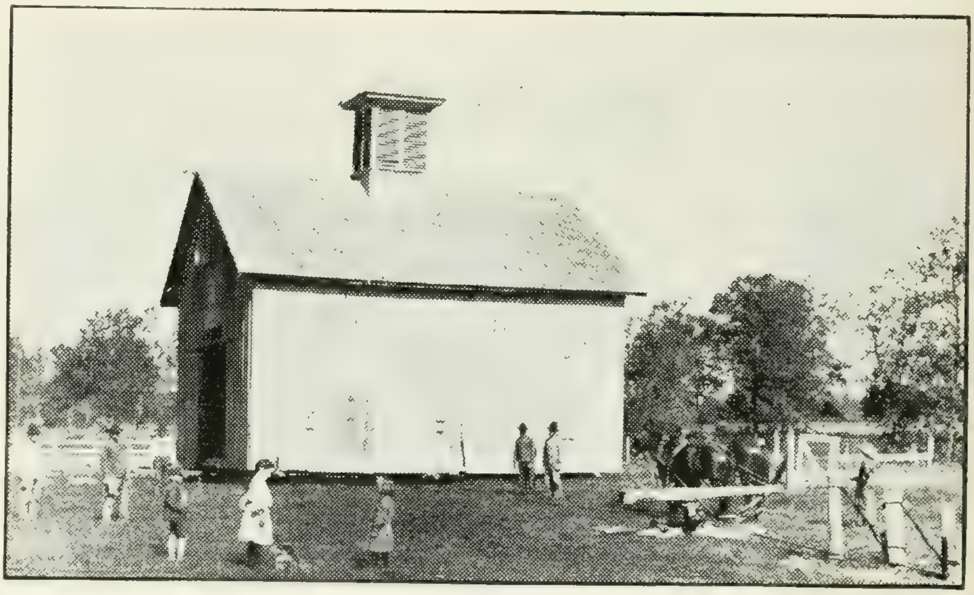


Fig. 6.—View Showing Building Being Moved With a Stump Puller.

In operating a puller, the cable should not be wrapped on the drum more than once, as it cuts itself if several thicknesses of cable are coiled on the drum. "Take ups," Fig. 3, should be used to prevent this.

Care must be exercised in placing the rope and hook around the stump. The rope should be fastened near the top of the stump, so as to get the greatest leverage, and the hook must be set as shown in Fig. 5. If the hook is placed so it kinks the rope, the hook will be easily broken, or else it will cut strands in the cable.

When stumps are pulled out of the ground, they should be cut up for easy handling, as with long roots on them they are very expensive to move. Many stumps can be handled if the roots are cut off with axes, while the largest stump can be broken up by dynamite by the method explained above. In cutting and breaking up stumps of hardwood trees, good knees that can be saved should be set aside to be sold, as they always bring a good price for ship building, and if convenient to ship them to market will help to pay for the grubbing. Contractors can often use them in building pile drivers and other machines.

In cutting timber where stumps are to be pulled, the stumps should be left high, as they are pulled much easier than when cut low. If the timber is valuable, a cord wood length (4 ft.) can be left above the roots and after the stump is pulled this can be sawed off.

Although the stump puller can pull trees, yet in most cases it is more economical to cut the trees and afterwards pull the stumps, especially if the trees are very large. Very small trees will bend and break if an attempt is made to pull them up. Trees from 9 to 15 ins. in diameter can be pulled with a stump puller.

A stump puller is likewise a useful machine in moving houses, especially if it can be thrown out of gear quickly. Contractors in clearing land for excavation frequently have frame buildings to move, and with a stump puller this work can be done cheaper than by almost any other method. In Fig. 6 we illustrate a house being moved by a stump puller manufactured by the Monarch Grubber Co. of Lone Tree, Iowa. This stump puller can be thrown out of gear by the operator upon signal, while there is a strain on the cable and the drum does not slip. This makes a horse winch as valuable for this class of work as a hand windlass. The building is jacked up and placed on new ways, extra timbers being put in the building to strengthen it wherever necessary, and then the puller is used to move it along on the runways. The puller should always be well anchored for this work.

Port works to cost $25,000,000 are proposed for Pernambuco, Brazil. Bids for the work will be opened March 26 by the Director-General of Public Works at Rio de Janeiro.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Twelve Additional Letters Commending the American Society of Engineering Contractors.

In answer to the editorials and invitations extended to engineers and contractors to apply for membership in this proposed society, Mr. Gillette has received scores of letters advocating the formation of such an organization.

The total number of applications now exceeds 750. It would seem therefore that the permanent organization should soon be effected. An application blank can be found on page 5 of the advertising section. In our last issue we printed 12 letters commending the formation of this society; 12 additional letters follow:

Sir:

I will be glad to have you enter my name as a charter member of the American Society of Engineering Contractors. I wish you success in your undertaking, for I feel that the society will prove to be of great value to both engineers and contractors.

Very truly yours,
M. S. Ketchum,
Dean Civil Engineering,
University of Colorado,
Boulder, Col.

Sir:

We are heartily in sympathy with your efforts to organize an American Society of Engineering Contractors. Both of the members of this firm are engineers in the contracting business, and we both desire to become charter members of the American Society of Engineering Contractors, provided of course the dues and conditions of membership are satisfactory. We shall be pleased to receive any information that may be forthcoming concerning this proposed society.

Very truly yours,
Harrison Clement,
Of Clement & Strange,
Salt Lake City, Utah.

Sir:

As engineer it falls to my lot to be intimately associated with the contractors and for that reason am very much interested in any movement that will give better mutual understanding. Wishing you the best of success in organizing the American Society of Engineering Contractors, I remain

Yours truly,
D. R. Kinkead,
Independence, Kansas.

Sir:

I enclose application for charter membership in the American Society of Engineering Contractors. I sincerely hope the conditions of membership will not prove to be too high. I am transitman and have been resident engineer and I believe that outside of contractors we are a grade who would be much, if not most, benefited by the knowledge of the contractors' side of the question and of the financial side of work going on all over the country and which membership in this society would give us a splendid means of acquiring.

Yours truly,
Apartado 459, H. E. McClintock,
Guadalajara, Mex.

Sir:

I heartily indorse your article in regard to the formation of a National Society of Engineering Contractors, if it will place contractors on an equal footing in the letting of contracts, and banish the use of money and of specifications drawn especially for certain bidders. I am not likely eligible to membership but have seen many specifications that were so drawn that one contractor would be ruined while another would be allowed to do much poorer work, given all the extra time he asked and make plenty of money.

Very truly yours,
W. G. Russell,
Hydrographer, U. S. Geo. Survey,
Russell, Kansas.

Sir:

Enclosed find my application for membership in the proposed American Society of Engineering Contractors. Being an engineer and interested in construction work such a society and myself could be of mutual advantage to one another. Hoping to hear from you soon,

Yours very truly,
T. W. Anderson,
Ottawa, Ontario, Canada.

Sir:

Please enroll me as a charter member of an American Society of Engineering Contractors. I desire to become a member unconditionally with one exception, and that is, the membership be restricted to engineers of standing so that the proposed society will command sufficient influence by the weight and character of its members to accomplish its aims.

These you have dwelt upon in your journal, and I wish to express myself as being in full sympathy with you in your efforts.

Very truly yours,
Gustave Kaufman,
Ch. Eng. Kosmos Engineering Co.,
Contractors,
Brooklyn, N. Y.

Sir:

I enclose herewith an application for membership in the American Society of Engineering Contractors.

I take the liberty of suggesting the advisability of adopting a name for the new society not so much like that of the American Society of Civil Engineers, with which it may naturally be confused.

Very respectfully,
F. W. Altstaetter,
Captain, Corps of Engineers, U. S. A.,
Pittsburg, Pa.

Sir:

Enclosed please find slip made out for membership in American Society of Engineering Contractors. In signing this I feel that I am signing with the best society that possibly could be organized in America. I also feel that it will be of the greatest advantage to both contractors and engineers.

Respectfully yours,
Thos. O'Hern,
Contractor,
Yonkers, N. Y.

Sir:

I enclose application for membership in your new society. I am now in Bolivia but am leaving tomorrow for the United States, to become general manager for MacArthur Brothers. Kindly send bill for whatever dues there are to me at that address, although I will not reach there until May 1st.

I am a member of the American Society of Civil Engineers and of the Engineers' Club. I think that your society will fill a long felt want and will be especially effective in suggesting how investigations should be conducted in examining bids for dam contracts.

Very truly yours,
F. C. Hitchcock,
Gen. Man. South American Con. Co.,
La Paz, Bolivia, S. A.

Sir:

Enclosed please find application for membership in Am. Soc. Engr. Contr., subject to provisions therein.

I desire to congratulate you on your efforts in this direction, and think the idea is a splendid one.

Yours very truly,
The Grattan Contracting Co.,
N. O. Tiffany, Jr., Vice-Pres-Sec'y.,
Buffalo, N. Y.

Sir:

Your idea of a National Society of Engineering Contractors appeals to me very much. Believe beneficial work can be done along that line.

Respectfully,
Joseph H. Stone,
Contractor,
Kansas City, Mo.

Methods and Costs; Some Old, Some New.

Depreciation of Electric Railways.—At the 1904 convention of the International Tramways Union, which comprises many European companies, the matter of depreciation was considered. It was found that practically all of the European companies anticipated depreciation by annual payments to a fund (the most common method) or charges to an account. Twelve of the companies turned annually into a renewal account or fund certain percentages of the cost of installation, varying as follows:

Tracks, etc	from 1% to 10%
Line construction	from 1% to 8%
Rolling stock	from 1.25% to 10%
Power station equip't	from 2.5% to 10%

After a careful study of practices it was suggested tentatively that the following percentages of first cost value be set aside annually as a renewal fund:

Rails, ties, switches, crossings, etc	1.9%
Poles (presumably iron)	1.0%
Wires, feeders, etc	4.0%
Cars	1.7%
Engines, generators, batteries, etc	4.0%

At the 1902 meeting of the Municipal Tramways Association of Great Britain, Mr. James Dalrymple, in his report on a standard classification of accounts, suggested depreciation credits to asset accounts, aggregating 18% of the gross expense or 13% of the gross receipts. The details were as follows:

	Per car-mile (in pence)	Pct. of cost value.
Electrical equipment of line	.30	4
Buildings and fixtures	.17	3
Power station and sub-station plant	.35	6
Workshop tools and sundry plant	.035	2
Cars	.23	8
Electrical equipment of cars	.23	8
Miscellaneous equipment	.02	5
Office furniture	.008	16

Hand Driven Sheet Piling Work.—The proposed center pier of a bridge was so located that the shore line at the then stage of water crossed one corner, leaving about two-thirds of the proposed excavation in the river and about one-third below dry land. Drill tests had shown loam or silt for 2 ft., gravel and boulders for 7 ft., and apparently rock at 9 ft., afterwards found to be boulders—with rock at about 14 ft. The depth of water increased gradually from the shore line to the outer edge of the excavation, reaching a depth of 7 ft. at that point. The pier was to be hexagonal in shape, and accordingly a heavy frame was built in that shape of 8x17 in. Oregon pine, thoroughly drift bolted together and braced. Two feet of earth was first cut out at the shore end, bringing it down to the water level; next a pair of heavy horses 4 ft. high were sunk in the stream, so that the tops were at the water surface. Planks were then laid from the 8x17 in. frame to these horses, and the frame raised on 1¼-in. water pipe rollers, and rolled out to place. The frame now rested on land and on horses beyond the center, one-third overhanging at about water level. Holes about 2 ft. deep were dug under the three landward corners of the frame and temporary posts set. The ground was then excavated as deep as convenient under the frame. Planks, 3x12 in., cut in 8-ft. lengths, and starting at the sharp point, were then stood outside of the frame and driven as deeply as practicable with a heavy wooden commander, consisting of a piece of railroad tie mounted on an ordinary hammer handle and bound with 1¼x⅜-in. iron rings. The 3x12-in. planks were cut beveled so each would cling to the last driven, making a fairly tight joint. When 10 or 15 of these had been driven on each side, the trench was backfilled on the outer side with stable manure and loam. The lines of sheeting were then continued out into the water, longer planks being used as the work progressed, until the horses interfered. Then several of the last piles were heavily spiked to the frame, the heads of the spikes being left out for convenience in pulling; the piles were then driven deeper. Two 3x12-in. pieces were also spiked to the outer-point as a further support and the horses removed. The placing of piles was then continued, and also the banking with manure and earth, until the proposed excavation was surrounded by a line of 3x12-in. sheet piling and an impervious bank of earth. Excavation was commenced by hand labor, the material being thrown out over the short planks that had been placed at intervals. The material changed to gravel and boulders as soon as the river silt had been removed, the ground being too firm to admit of driving the sheet piling except as it was removed from below the points by shovel. The sheeting also began sloping inward from the bottom, so a second frame of 6x12-in. timber was built within the excavation at the bottom of the piling, and the driving of the latter continued, the second frame being dropped as the excavation proceeded. At this depth it was necessary to throw the excavation onto intermediate stages supported by the upper frames and braces, and from there to throw it over the piling. At 7 ft. below the original surface, where rock was expected, nothing but boulders were encountered. The limit of the piling had been reached, but it was decided to go 6 ft. deeper. The lower frame now stood about a foot above the lower tips of the piling. On the bottom of the pit, so that its outside face should be 3 ins. inside of the inside line of the two other frames, a third frame of 6x12-in. Oregon pine was built in the same form as the others. A second line of sheet piling was then set between the two lower frames, short pieces being placed temporarily under the braces. The extra thickness of the rough timber made this somewhat difficult and resulted in slanting the bottom outward, which proved a very desirable feature. Soon after the inside piling was started the flow of surface water became too great to be handled by the pumps available and work was stopped, being finally resumed with a larger pump. No further difficulty was encountered in carrying the excavation down 5 ft., where rock was found.

Data on Painting Railway Bridges.—The following data on scraping and painting two railway bridges were given by Mr. A. S. Markley at a convention of the Association of Railway Superintendents of Bridges and Buildings. The bridges were both painted in 1896, bridge No. 1 being painted during the summer and bridge No. 2 during October and November. The structures are viaduct, with lattice columns and lattice struts in towers. The total number of tons of iron in bridge No. 1 was 719; in bridge No. 2 there was 154 tons of iron.

Bridge No. 1, 1st coat:	Total.	Per ton Iron.
Red lead, 3,560 lbs, at $.049	$174.44	$0.242
Boiled oil, 177 gals, at .40	70.80	.098
L. black, 18 lbs, at .085	1.53	.002
Labor	558.39	.776
Total	$815.16	$1.118
Bridge No. 1, 2d coat:		
Red lead, 2,395 lbs, at $.049	$117.35	$0.163
Boiled oil, 160 gals, at .40	64.00	.089
L. black, 55 lbs, at .085	4.67	.006
Labor	372.08	.517
Total	$558.10	$0.775
Bridge No. 2, 1st coat:		
Red lead, 500 lbs, at $.049	$ 24.50	$0.159
B. L. oil, 18½ gals, at .40	7.40	.048
L. black, 5 lbs, .085	.43	.003
Labor	121.41	.788
Total	$153.74	$0.998
Bridge No. 2, 2d coat:		
Red lead, 335 lbs, at $.049	$ 16.41	$0.106
B. L. oil, 17 gals, at .40	6.80	.044
L. black, 10 lbs, at .08½	.85	.005
Labor	89.90	.584
Total	$113.96	$0.739

Summary:

	Bridge 1. Per ton iron.	Bridge 2 P.t. iron
Labor	1.294	1.372
Labor and material	1.896	1.731
Material	$0.602	$0.359
Labor, scraping	.194	...
Labor, painting, 1st coat	.776	.788
Labor, painting, 2d coat	.517	.584
Pounds of red lead, 1st c't	4.95	3.25
Pounds of red lead, 2d c't	3.33	2.17
Gallons boiled oil, 1st coat	.246	.120
Gallons boiled oil, 2d coat	.222	.110

Method and Cost of Road Treatment with Tar and Oil in Rhode Island.*

BY ARTHUR W. BLANCHARD.†

In order that the results of maintenance experiments may be of maximum value to the highway engineer a description of the method employed on any specific highway or in a particular locality must be accompanied by a statement regarding local environments and the nature of the traffic to which the highway is subjected. The author, while reviewing descriptions of experiments in highway preservation in America, England, France and Germany, constantly felt the lack of adequate explanations of local conditions and an indefiniteness as to the cost of the various methods of construction. In the following paper the descriptions and cost data have hence been elaborated wherever possible in order that the results of the experiments in Rhode Island would be of maximum value to those who might use them. As the experiments herein described were made on highways differing widely in local characteristics, it will be advisable to consider a tentative classification of the country highways. The conditions in Rhode Island are typical of many states and hence the proposed classification of highways is not local, although the continuous state highway system per se has not as yet been adopted elsewhere.

It is practicable to recognize three classes of highways existing outside of the city limits, the classification being based on the amount and character of the traffic to which the roads are subjected. Naturally these classes merge into and overlap each other in many cases, but the classification will suffice as a basis for comparison. The first class includes interstate trunk lines and the popular routes of travel. The second class includes interstate trunk lines passing through towns, the highways connecting towns situated within a few miles of each other and the secondary streets of towns. The third class includes feeders leading to towns and highways of the first and second class from sparsely populated parts of the country districts, those connecting towns which are many miles apart and the transverse feeders in towns.

The highways of the first class will undoubtedly be subjected to the heaviest motor car traffic, although not necessarily to the heaviest commercial traffic. The highways of the second class will probably carry heavy commercial traffic and a limited amount of motor car traffic. The third class of highways will usually be subjected in amount at least to the ordinary country highway traffic.

The maintenance of the highways of the third class which are constructed either of earth, gravel or broken stone, has been thoroughly and satisfactorily considered in the past. The highways included in the first and second classes, being subjected to a more or less heavy motor car traffic and an augmented commercial traffic, demand an entirely different method of maintenance and in many cases a modified construction of the broken stone surface. The amount of traffic and the speed attained by motor cars are the important facts to be considered in the discussions of methods employed for maintaining highways of the first and second class.

The experiments with tar and oil on the highways of Rhode Island have been undertaken for divers reasons. In many cases the primary object has been to reduce the amount of dust raised by a motar car to a minimum. In other cases the work was undertaken with the double purpose of reducing the amount of dust to a minimum and preserving the surface. Again the experiments have been made with the primary object of increasing the life of the road.

The construction of tar macadam in 1906 and 1907 on the post road in the town of Charlestown was done under the supervision of the state engineers, the object being to obtain a road at a minimum of cost which would withstand the destructive wear of swiftly moving motor cars. This state road is a part of the interstate trunk line connecting New York city, Narragansett Pier, Newport, Providence and Boston, and hence belongs to class number one. With the exception of the addition of tar, the method of construction used was similar to that employed in the building of an ordinary macadam road. After the subgrade had been thoroughly rolled, the No. 1 broken stone, varying in size from 1¼ to 2½ ins. in their longest dimensions, was spread to a depth of 6 ins. and rolled to 4 ins. Tar, which had been heated in an ordinary tar kettle to the boiling point, was then sprinkled on the rolled surface by means of dippers. The No. 2 stone, varying in size from ½ to 1¼ ins. in their longest dimensions, was next deposited on dumping boards and thoroughly mixed with hot tar with the aid of rakes and shovels. This mixture was applied on the number one course to a depth of 3 ins. and rolled to 2 ins. A thin coat of dust, which would pass through a half inch mesh was then spread on the surface and then rolled into the No. 2 course to fill up the voids and to provide a smooth surface. It is without doubt unnecessary to state that the work was carried on only when the broken stone was dry.

The tar used in 1907 was produced at the Providence Gas Works and cost f. o. b. Providence $2.75 per barrel. The freight from Providence to Niantic, the nearest railroad station, was $0.41 per barrel. The cost of the haul from Niantic to the state road, a distance of 6½ miles, was $0.50 per barrel. The barrels cost $0.75 each, which amount, minus the freight to Providence, would be refunded by the gas company upon the return of the barrels. The location of the road rendered the return of the barrels an uneconomical procedure. The total cost of the tar per barrel was therefore $4.41. As two barrels of tar were used per 50 lin. ft. of road, 14 ft. in width, the cost per square yard of the tar used was $0.1132. The extra labor employed comprised three men at 20 cts. an hour and two men at 17½ cts. per hour. As the working day was 10 hours and 100 lin. ft. of macadam surface was built per day, the cost per square yard for the labor was $0.0609. The cost of accessories, which would include rent or interest and depreciation of tar kettles and dippers and cost of fuel, was $0.0054 per square yard. The saving per square yard by not using a watering cart at $4 per day for 10 hours was $0.0171. The total cost per square yard therefore of the tar macadam in excess of the ordinary macadam was $0.1624. The amount of tar used per square yard was 1.15 gals.

In the fall of 1906 350 lin. ft. were constructed, the location being on a curve section of the interstate trunk line in Charlestown. This sample withstood the severe test of a hard winter admirably, and likewise resisted the wear of the traffic during 1907 without perceptible alteration. As these results were gratifying, the state board, during the fall of 1907, constructed the mile of tar macadam referred to above. Although this experiment was undertaken with the primary object of securing a more permanent surface, another desideration resulted—namely: the elimination of the objectionable dust. After a tar macadam road, constructed as described, has been in service a month a large percentage of the loose dust is either washed away by the rain or has been raised from the surface, primarily by the motor car, and blown away by the wind.

During the construction of the above road there would occur at irregular intervals small areas of a spongy nature. The lustre of the tar was lacking on the coated stones and the entire mass appeared to be impregnated with oil. Without doubt this condition was due to a lack of uniformity in the composition of the tar mixture in the several barrels used. It is well known that the percentage of ammoniacal liquors, light oils and water in a given barrel of tar depends to a great extent upon the amount of tar in the tank from which the contents of the barrel were drawn, and also upon the nature of the treatment at the gas works.

During the fall of 1907 Central street, Narragansett Pier, which belongs to the second class of highways, was built of tar macadam, the penetration method of construction being adopted. The tar compound used, known as tarvia, was furnished by the National Coal Tar Co. of Boston, the amount used per square varying from 0.81 to 1.61 gals., depending upon the size of the broken stone comprising the upper course.

---

*A paper read before Section D of the American Association for the Advancement of Science.

†Associate Professor of Civil Engineering at Brown University and Assistant Engineer State Board of Public Roads of Rhode Island.

The macadam was constructed by spreading 6 ins. of clean, dry No. 1 Connecticut trap rock on the rolled subgrade and rolling the same to 4 ins. On the No. 1 course was then spread 2½ to 3 ins. of clean, dry No. 2 Connecticut trap rock, which was lightly rolled. The tarvia, which had been heated in the regular tar kettles, was next poured on the surface of the No. 2 course and allowed to penetrate. The depth of penetration varied from 1 to 2 ins., depending on the size of the stone comprising the upper course and the amount of rolling the surface had received. Trap rock chip screenings were then spread to a depth of ½ to ¾ in. and thoroughly rolled. There is no apparent reason why this form of construction should not give satisfactory results, but a year's service under traffic will be required before any opinion relative to its durability can be expressed.

As yet the Gladwell system of constructing tar macadam has not been tried in Rhode Island, but without doubt will be experimented with during the coming season. This system consists in spreading on the No. 1 course, after rolling a mixture of tar and chippings, to a depth of ¾ in. On this is deposited from 2 to 3 ins. of No. 2 broken stone, which is thoroughly rolled, thus forcing the mixture into all the interstices of the No. 2 course. The upper surface is sealed by painting with tar, after which a thin coat of fine screenings is spread and rolled.

PERCENTAGE OF VOLATILE MATTERS AT VARIOUS TEMPERATURES.

Samples.	Tarvia.	Tar.	Tar.	Terra-colio. No. 3.	Terra-colio. No. 2.
Volatile at 120° F.	12.35	10.66	6.77	0.53	14.46
Additional loss at 212°-220° F.	17.28	15.33	16.12	0.18	5.88
Additional loss at 240°-260° F.	6.48	4.67	4.99	0.18	0.67
Total volatile matters at 260° F.	36.11	30.66	27.88	0.89	21.01

ANALYSIS OF SAMPLES DIGESTED WITH EQUAL VOLUMES OF WATER.

	Tarvia.	Tar.	Tar.	Terracolio No. 3.	Terracolio. No. 2.
Color	Water white.	Brown.	Brown.	Water white.	Water white.
Odor	Carbolic Acid.	Carbolic Acid.	Carbolic Acid.	Slightly tarry.	Slightly tarry.
Reaction	Slightly Acid.	Alkaline (Free ammonia).	Alkaline (Free ammonia).	Neutral.	Neutral.
Total solid matters, grains per gallon	8.75	46.69	102.15	5.84	11.68
Organic and volatile	8.75	37.94	99.23	2.92	5.84
Mineral matters	None.	8.75	2.92	2.92	5.84

The construction thus far employed of using tar as a preservative for roads already constructed is known as the painting method. In the fall of 1906 a section of 1,300 ft. in length of the state road in the town of Tiverton was painted with tarvia furnished and applied by the National Coal Tar Co. The usual method was employed of sweeping the dust from the surface of the macadam with stiff brooms, thus exposing the mosaic surface of the No. 2 course. The hot tar was poured on the No. 2 course and spread by brushing. A thin coat of sand was then spread over the tarvia coating. The price per square yard was $0.0804. This section was located on a hill having a maximum grade of 7.28 per cent, hence the durability and slipperiness during the service of the first year were carefully noted. The tarviated surface was able to shed the water to the gutters and to prevent the road from being gullied, while, contrary to the experience of English engineers with steep gradients, no unfavorable criticisms have been offered relative to slipperiness. The state road in Tiverton belongs to the second class, but it is subjected to more than the average amount of motor car traffic, as it is a part of the interstate trunk line leading to the popular summer resort, Newport. After sustaining a season's motor car traffic, the road surface has not scaled or been worn down to the No. 2 course.

In 1906 tar painting was experimented with on two curves on an interstate trunk line in the town of South Kingstown. In both cases the edges have continually worn or scaled off.

During the month of August, 1907, one mile of macadam road of the second class, located in the village of Peacadale in the town of South Kingstown, was tarviated. The method employed was similar to that used on the Tiverton road, except that the tarvia in this case was heated to 200° F. in a special tarvia heater and spread directly from the tank car. The price per square yard was reported as $0.0487. As a whole the work has proved satisfactory, although the tarvia coating has scaled off in spots and on the edges.

The evident variation in the quality and composition of the various barrels of tar used on the same highway and the recognition of the possibility of securing a more efficient binder were instrumental in having samples of tar examined and analyzed. Thus far five samples of materials of a tarry composition which could be used in tar macadam or as a surface palliative have been analyzed. These include one sample of tarvia furnished by the National Coal Tar Co. of Boston, two samples of coal tar furnished by the Providence Gas Co. and two samples of terracolio furnished by the Good Roads Co. of America. The results are shown in the accompanying table.

It should be noted that the percentage of volatile constituents which evaporated at 120° F. fairly represents the percentage which would be lost from the tarred surface of a highway during a summer season. The object of digesting the tar in water was to determine the amount of matter which might be washed from the surface of a road by a heavy rain. This combination was not shaken vigorously, but simply turned once in order to obtain experimental results which would conform to actual conditions on the highways.

The results obtained from the analysis of the samples of tar from the Providence Gas Co. indicate that the variation in composition may have an important influence on the character of a tar macadam road. The fact that only one sample of the other tar products was analyzed should be considered in drawing conclusions from the results tabulated.

Judging from the results tabulated, it is obvious that if it is desirable it will be possible by washing the crude tar with water and heating a certain number of hours at a temperature of 120° to 150° F. to remove those constituents which would volatilize or be washed away during the first season of service. The spongy nature of certain portions of the tar macadam at Charlestown and the self-evident possibility of a porous tar macadam road under certain climatic conditions indicate the desirability of experiments with tar which meets certain definite specifications. Without doubt this phase of the use of tar will be thoroughly investigated during the season of 1908.

The treatment of macadam roads with oil during 1906 and 1907 by the State Board of Public Road was undertaken with the idea of not only suppressing the dust but also of preserving the road surface. Without doubt some of the towns in Rhode Island which have experimented with oil only considered the results from the standpoint of the solution of the dust problem. During the month of July, 1907, 32,242 sq. yds. of the state road in the town of Barrington were treated with an oil known as "petroleum residuum," which was supplied by the Standard Oil Co. from its tanks at Bayonne, N. J. The oil was applied cold by means of an ordinary sprinkling cart to the surface of the road from which the dust had not been removed. The amount of oil applied per square yard was 0.214 gal. The cost of the oil in the tank cars at Barrington Center, which is on the state road in question, was $0.046 per gallon. The cost of the labor per square yard was $0.0031, making the total cost per square yard $0.0105. Some damage was done during the three or four days following the application, particularly to motor cars, carriages and wearing apparel, but the coagulated dust did not pick up after the traffic had matted the surface, except during and immediately following a hard rain. The treatment was successful from the standpoint of suppressing the dust, and as the retention of the dust preserves the surface of a macadam road it has without doubt increased the life of the road. The application of the oil, however, did not furnish a binder of sufficient tenacity to prevent the No. 2 course from raveling when it was subjected to a combination of unfavorable climatic conditions and heavy motor car traffic. The efficacy of this treatment was apparent after five months of service, but it is not expected that the surface will be in such condition in the spring as not to require a second application in order to make the road dustless. This highway belongs to the second class, receiving the normal amount of motor car traffic for roads of this type.

ANALYSIS OF OILS OFFERED AS DUST PREVENTIVES.

Sample.	Petroleum Residuum.	Fuel Oil.	Ragland Crude Oil.	Dustoline.
Specific gravity	0.907	0.854	0.909	0.854
Flash point	240 Fahr.	105 Fahr.	180 Fahr.	260 Fahr.
Burning point	300 Fahr.	170 Fahr.	220 Fahr.	390 Fahr.
Volatile at 120° F	14.91%	2.25%	14.13%	1.14%
Additional loss at 212°-220° F	6.98%	49.01%	8.64%	6.62%
Additional loss at 240°-260° F	9.71%	30.42%	6.86%	13.01%
Total volatile matters at 260° F	31.60%	81.68%	29.63%	20.77%

ANALYSES OF SAMPLES DIGESTED WITH AN EQUAL VOLUME OF WATER.

Sample.	Petroleum Residuum.	Fuel Oil.	Ragland Crude Oil.	Dustoline.
Color	Water white.	Water white.	Water white.	Water white.
Odor	None.	Petroleum.	None.	Paraffin Oil.
Reaction	Neutral.	Acid (Free Sulphuric Acid).	Neutral.	Neutral.
Total solids, grains per gal	Trace.	52.53	5.83	5.84
Organic and volatile	Trace.	52.53	5.83	2.92
Mineral matters	None.	Trace.	None.	2.92

The highway commissioner for the town of Cranston has used oil on the town roads since 1901. The highways with but two exceptions belong to the second and third classes, the two exceptions being parts of interstate trunk lines on the state highway system. The effect of one application has lasted from ten to thirteen weeks, hence the usual practice has been to make two applications per year. The oil used, petroleum residuum, is obtained from the Standard Oil Co.'s plant at Bayonne, and costs delivered in tanks on side tracks in Cranston $0.046 per gallon.

The state road in the town of Middletown belongs to the first class, for although it is an intrastate trunk line, it is at the same time part of one of the popular drives out of Newport. This highway was treated during July, 1907, with dustoline, the number of square yards covered being 20,765. The dustoline was spread by means of a watering cart on the surface of the road from which the dust had not been removed. The total number of gallons used on the work was 7,261, but as some sections received two applications the amount used per square yard is indeterminate. The dustoline cost, f. o. b. Summit, N. J., $0.0775 per gallon, the total cost being $562.73. As the freight from New Jersey to Providence was $69.70 and the cost of labor required to spread the material was $97.66, the average cost of the application per square yard was $0.035. The efficacy of the treatment from the standpoint of laying the dust has not been questioned. After three months the effect of the application had practically disappeared. An objection to its use has been offered due to the fact that motor cars throw small coagulated particles of dust into the air, which are decidedly injurious to wearing apparel.

Dustoline has been used on many of the principal boulevards of Newport, giving perfect satisfaction, according to the statements of the officials of the Department of Streets and Highways. The object of the treatment was to suppress the dust more satisfactorily and economically than had previously been done by watering.

The many varieties of oil offered to the State Board of Public Roads suggested the advisability of analyzing some of the oils used as palliatives. The samples included three varieties furnished by the Standard Oil Co. and a sample of dustoline furnished by John S. Lamson, Jr. The results are shown in an accompanying table.

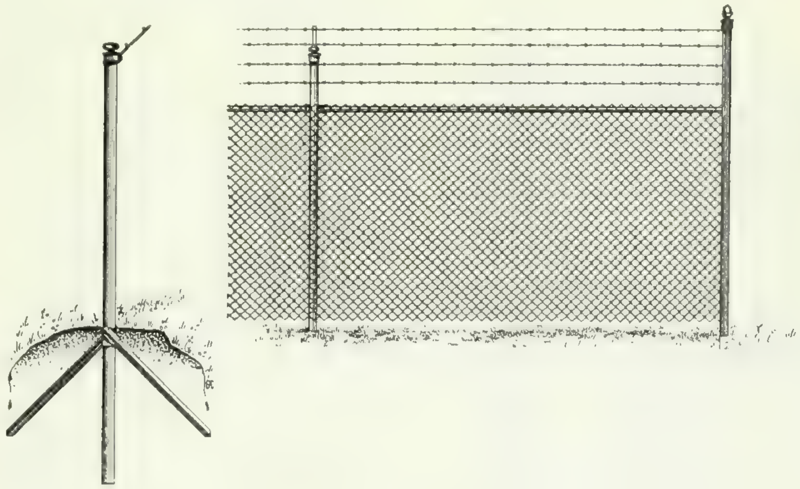
Judging from the results of the experiments made in Rhode Island and elsewhere, it is obvious that investigations should be made during the coming season covering the following important subjects: 1, Relation of the composition of tar to the efficiency of a tar macadam road and tar painting. 2, Comparison of the efficiency of tar macadam constructed under varying climatic conditions by the mixing method employed at Charlestown, by the penetration method and by the Gladwell system. 3, Economic value of loosening three or four inches of an old macadam road with a scarifier, reshaping the surface and reconstructing the surface with the addition of tar by the penetration method. 4, Methods of increasing the bond between the tar matrix and the surface of an old macadam road. 5, Efficiency of various machines used for spreading tar and special machinery used in the construction of tar macadam roads. 6, Efficiency of roads treated with the various oils on the market, with cold and hot oils, with and without the sand dressing, with and without rolling.

The author firmly believes that in the future more stress should be laid on the economic construction of more permanent macadam roads for highways of the first and second classes and that less attention should be paid to the various surface palliatives.

An Unclimbable Fence.

We illustrate herewith a new type of fence that is being used to enclose factories, reservoirs, filter plants, railroads and public institutions. This fence being made of No. 6 galvanized wire, woven or linked together into a small mesh, makes a strong netting. The posts are of iron and are driven into the ground, instead of being set in holes. When driven to the proper depth two stakes of angle iron are driven through a socket fastened to the base of the post, thus forming an anchorage against the action of frost or any strain to which the fence may be subjected.

The netting, made in widths of 6, 7 and 8 ft., is securely stapled to the steel posts and wired to a top rail of standard pipe. Above this, two or more strands of barbed wire are usually placed on a diagonal arm bolted to the top of the post. This makes a strong fence that is said to be unclimbable, and sightly, much more so than a board or paling fence.



A New Type of Wire Fence.

It will answer the purpose of both the board fence and the wire fence, and it is claimed that it possesses many advantages over each. It is said that a fence of this character will last twice as long as a board fence, while the first cost is approximately the same, or very little more than a board fence of equal height. This fence is being put upon the market by the Anchor Post Iron Works of New York City.

Meter Box Cover for Sidewalk Setting of Water Meters.

Some 5,000 of the meter box covers shown in the accompanying illustrations, Figs. 1 and 2, have recently been installed at Washington, D. C. The cover as will be seen is designed for sidewalk setting of the meter box. The advantages claimed for this type of meter setting over the usual cellar or basement installation are ready accessibility for reading, inspection or repairs, protection from frost, fire or damage of any kind and security against meter tampering. Much time is often lost by the meter reader in gaining access to the home of a consumer and reaching the meter, and the meter itself is often covered over with barrels, boxes or other household waste which has to be removed. Few cellars are heated sufficiently to prevent freezing of meters in extreme cold weather, and this alone is said to be the source of heavy loss every winter. In case of the destruction of a house by fire the meter is always a total loss.

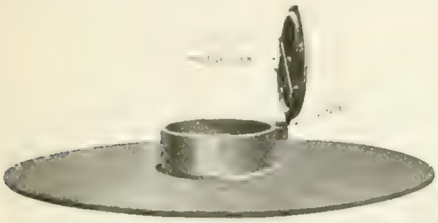


Fig. 1.—Cast Iron Cover.

With the outside setting, the meter can be readily reached by simply unlocking and raising the iron cover at the pavement level. Tests have shown that when the thermometer stood at 10 degs. below zero in the street the temperature at the meter dial in the street box (16 ins. below the pavement level) was 42 degs. above zero, making a difference of 52 degs. in temperature between the outside and inside of the box. The theory is that the warm air rising from the ground at the bottom of the box keeps the box or pit warm even in the coldest weather, and users of this setting in the extreme north claim they have never had a meter freeze in them.

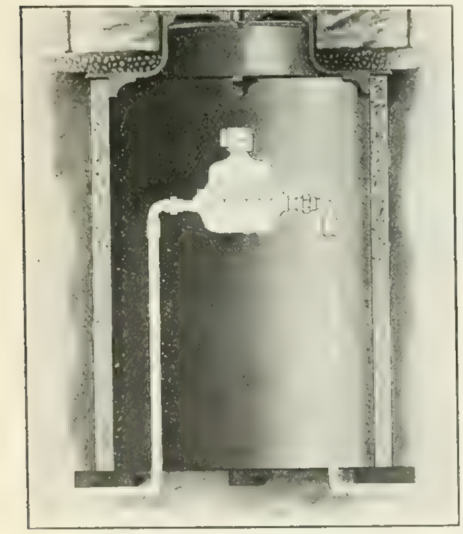


Fig. 2.—Model Setting of Cover.

One of the accompanying illustrations shows the cast iron cover and the other a model setting of the cover used with vitrified or cement pipe box body. These covers are made by the McWane Pipe Works, 220 Broadway, New York city.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0630. **Contractors' Machinery and Supplies.**—Union Elevator & Machine Co., Chicago, Ill.

This 140-page catalog of general contractors' machinery contains a particularly complete list of derricks, cranes, hoists, tackle and hoisting machinery equipment and supplies. The catalog has a full index.

No. 0631. **Machinery and General Supplies.**—H. Channon Co., Chicago, Ill.

This is a general illustrated catalog and price list of machinery, apparatus, supplies and tools made and handled by the company named for steam and electric railways, contractors, bridge builders, stone quarries, machine shops, factories, mines, saw, paper, flour and cotton mills, elevators, electric light, power and water-works plants, etc. The catalog contains 832 pages with index, is cloth bound and should be had by every purchaser of materials and machinery.

No. 0632. **Steel Wire Ropes.**—Broderick & Bascom Rope Co., St. Louis, Mo.

This 72-page pamphlet of pocket size contains much information useful to the user of wire rope in addition to the regular catalog data on rope, fittings, sheaves, aerial ropeways, etc. Wire rope construction is explained by diagrams and definitions and there are notes on the use and care of wire rope, directions for splicing, tables of strains, etc.

No. 0633. **Portland Cement.**—St. Louis Portland Cement Co., St. Louis, Mo.

This pamphlet is interesting for its reprint of the original granitoid specifications for sidewalk construction. There are also a number of good illustrations of large bridges, buildings and other structures in which the above named company's Red Ring brand of cement has been used.

No. 0634. **Concrete Mixers.**—Waterloo Cement Machinery Co., Waterloo, Iowa.

The Polygon mixer described and illustrated in this 25-page pamphlet is a batch mixer of the tilting type. The mixer is described and illustrated and tables of dimensions, outputs, power required, etc., are given for various sizes.

No. 0635. **Stone Crusher.**—Universal Stone Crusher Co., Cedar Rapids, Iowa.

The crusher described and illustrated in this pamphlet is known as the Velten crusher, invented and long used in Germany, and now being made by the above named firm in the United States. The crusher is of the jaw type with a special four motion action of the jaws, which is claimed to give unusual efficiency. Another feature is the instantaneous adjustment of the machine to produce fine or coarse stone. The crusher will produce material fine enough for sand for concrete.

No. 0636. **Wire Rope.**—A. Leschen & Sons Rope Co., St. Louis, Mo.

This is one of the handsomest catalogs that we recall. It contains 87 pages, of which some 35 pages are devoted to illustrations and tabulated data of the various sizes, styles, and constructions of wire rope made by the above named firm. The illustrations of rope structure in this section are remarkably handsome examples of half-tone and color engraving. The first 52 pages contain descriptive text on wire rope structure and construction, on various steels for wire rope and their advantages for special purposes, on rope tramway construction in detail, on tail rope systems, endless rope systems, cableways, mine haulage, logging work, wire rope power transmission and on splicing wire rope. The pamphlet is well worth having on file.

No. 0637. **Portland Cement.**—Edison Portland Cement Co., New Village, N. J.

This pamphlet contains a large number of fine half-tone views of the above named company's works and of structures built of Edison cement. Fineness of grinding greater than other cements is claimed for Edison cement and the pamphlet contains many interesting data on this point.

No. 0638. **Cement Working Machinery.**—Cement Tile Machinery Co., Waterloo, Iowa.

This pamphlet lists a special line of machines and tools for concrete block and tile molding works. Perhaps the machine of most interest is the company's cement drain tile machine, which is practically automatic in action and continuous in operation. Molds are also shown for tile making by hand.

No. 0639. **Creosoted Timber and Its Uses.**—Kettle Rivers Quarries Co., Minneapolis, Minn.

This pamphlet will be of general interest to anyone interested in timber preservation by creosoting. A concise history of wood preservation is followed by a discussion of principles, definition of creosote oil and method of treatment. The creosoting plant of the above named company is described and sections follow on creosoted paving blocks and timber. Specifications are given for paving block, piling, cross-arms and structural timber. The pamphlet is a good one.

No. 0640. **Dump Wagon Boxes.**—The Troy Wagon Works Co., Troy, O.

This 12-page pamphlet illustrates and describes the Troy bottom dumping wagon box designed to be applied to ordinary teaming or farm wagon gears when dumping wagons are wanted. The box is in all essentials the same as that of the well known Troy dump wagon.

No. 0641. **Rock Crushing Machinery.**—Power & Mining Machinery Co., Cudahy, Wis.

This 72-page pamphlet describes and illustrates an excellent line of gyrating and jaw crushers, bins, elevators, screens, cars, conveyors, etc., for stone crushing plants, and also gives line drawings of arrangements of complete plants for various locations and outputs. The gyratory crusher is the McCully machine and its construction is described in detail with tables of dimensions. The pamphlet gives a diagram for determining at a glance the percentages of the different size products delivered by the first crusher in order to determine the size and number of auxiliary crushers, which should be in the hands of every contractor for crushed stone.

No. 0642. **Elaterite.**—The Elaterite Paint & Mfg. Co., Des Moines, Iowa.

These pamphlets explain the use of elaterite or "mineral rubber" for waterproofing and for preservative coatings for metal structures. They are worth securing and reading by engineers. Tests are given showing the paint to be unaffected by acids and alkalies, and two papers, one read before the American Society for Testing Materials, and one before the Iowa Cement Users Association, give results of the use of elaterite in painting steel structures and in waterproofing concrete, respectively. The pamphlets present a strong argument for the value of this material.

No. 0643. **Steam and Air Drills.**—Wood Drill Works, 30 Dale Ave., Paterson, N. J.

In this 28-page catalog the various parts of the Wood drill are described, and cuts shown of them, also the nine different size drills that the firm manufactures; also all drilling accessories, such as tripod, columns, blacksmith's tools, oilers, hose and tool steel. The catalog is of attractive appearance and will be useful to those engaged in rock drilling.

No. 0644. **Dynamite.**—Aetna Dynamite Co., 143 Dearborn St., Chicago, Ill.

This 66-page catalog might be called "some useful suggestions in handling and using explosives." In it are described the products of the Aetna Co., dynamite, contractor's powder and Miami blasting powder. Such supplies as caps, fuse, batteries and electrical exploders are also shown, and their uses commented upon. Every contractor should have one of these valuable pamphlets.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750

NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt

BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . Managing Editor
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . . Associate Editors
MYRON C. CLARK . . . . Manager
A. B. GILBERT . . . . Advertising Manager

SUBSCRIPTION RATES (Payable in Advance):— ***$2.00*** *a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*

$2.50 *a year (52 issues) to Dominion of Canada.*

$3 00 *a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

Shall the Government Operate Dredges 185
Educational Advertising 185
The Quebec Disaster Teaches the Need of Courage in Questioning the Opinions of Eminent Men 185

CONCRETE SECTION:

Comparative Advantages of Loose Bar and Unit Frame Systems of Reinforcement 186
Reinforced Concrete in the Construction of Highway Bridges and Culverts 187
A New Unit Hooped Column Reinforcement 189

EARTH AND ROCK SECTION:

Method of Building the Tunnel of the Detroit Water Works 190
A Protest Against Government Ownership of Dredges 191
The Shrinkage of Earth in a Colorado Reservoir Dam 192
Diagram for Determining Percentage of Different Sizes of Stone Delivered by Rock Crushers 192

ROADS AND STREETS SECTION:

The Binder Course in Asphalt Paving . 193
The Average Unit Cost of Pavement Laid in 1907 in Representative Cities, Together with the Wages of Labor and Cost of Paving Materials 194
Detailed Cost of Jobs of Laying Asphalt Pavement in a Southern California City 195

GENERAL ARTICLES:

Twelve Additional Letters Commending the American Society of Engineering Contractors 199
The Cost of Building Electrical Conduits in Baltimore 201
METHODS AND COSTS 200

Shall the Government Operate Dredges?

Elsewhere we print part of a splendid argument against government ownership of dredges, as presented by Mr. William Ryan, Secretary of the Dredge Owners' Protective Association.

In our issue of Oct. 31, 1906, under an editorial entitled "Is Government Dredging by Day Labor Cheaper than by Contract, as Claimed by Engineering News?" we exposed the fallacy of the claim that the dredging of Ambrose Channel was being done more cheaply by government dredges than it had been done by contract. In like manner Mr. Ryan has shattered other similar claims of economy of government labor.

In order to protect themselves from the continued encroachments of the government upon their field of action, the dredge owners of America have formed an association. Their only weapon of defense is publicity, but that weapon is sufficient, for there never has been and there never will be a government capable of doing any sort of work by day labor with as great economy as it can be done by contract. We are not speaking now of an occasional spasmodic spurt, but of continuous action through a period of years.

The contract system may and does have its imperfections, and it may be that it is the existence of these imperfections that has led engineers at times to condemn it in its entirety. But the wiser plan will unquestionably be to perfect the contract system by perfecting the specifications under which it is done, and this is one of the objects of the American Society of Engineering-Contractors.

Quoting from the editorial above mentioned, we say again: He is not a wise surgeon who tries to cure a man who squints by cutting off his legs.

An Engineering Book Given Away By A Certain Manufacturing Firm For the Purpose of Educational Advertising

Not content with ordinary catalogs, there is a tendency among a few manufacturers to prepare books for free distribution—books that are really not catalogs at all. One of the most noteworthy of these productions is the 250-page book, "Reinforced Concrete in Factory Construction," published by the Atlas Portland Cement Co., and briefly described in one of our advertising pages. The author of this book is a well known engineer, and it is for this reason that we call special attention to it.

A few years ago it would have been considered folly to go to the expense of employing an engineer to write a 250-page volume for free distribution. Now, however, there are many firms that realize that trade literature should be real *literature* to be most effective. Catalogs filled with photographs of machines, etc., will always have a certain usefulness, but there will be an ever increasing amount of technical information in the form of good text not only in catalogs but in advertisements.

Advertisements, we may add, may be divided into three classes:

(1) Publicity advertisements.
(2) Educational advertisements.
(3) Drumming advertisements.

A publicity advertisement may be defined as one that appeals to the eye or ear rather than to the reason; as an example, "Wilson's highball—that's all." Undoubtedly this sort of advertising, if well done, is effective, and particularly so in marketing goods of small unit cost.

An educational advertisement is one that is aimed to increase the general use of a product, like Portland cement, by showing how to use it and by presenting its merits. An advertisement that explains why dump wagons are more economical than slat-bottom wagons is an educational advertisement. Few advertisers appreciate the effectiveness of this sort of advertising. Most advertisers shun it, evidently under the belief that it is a labor of love; but, as a matter of fact, any firm that conducts an intelligent campaign of educational advertising is sure to reap a good harvest, for its name thus becomes synonymous with the product whose use it is endeavoring to extend.

A drumming advertisement is one that aims to sell a particular machine by a salesman's arguments as to its advantages over competing machines. This sort of advertising has also proved very effective in many cases, and is destined to be used more and more frequently.

An engineer having knowledge of the uses of a machine or product is particularly well qualified to write educational advertisements. If he also possesses an argumentative talent he can succeed as a writer of drumming advertisements.

Technical advertising is an art that is in its infancy, and fortunes will be made by individuals and firms who devote their best thoughts to it. We call attention to this field as being one that many an engineer may profitably enter.

The Quebec Disaster Teaches "A Lesson of Humility," Says the Engineering News—Does it Not Teach the Need of Courage in Questioning the Opinions of Eminent Men?

Speaking of the blunders made in the design of the Quebec bridge, which led to its destruction, Engineering News says:

"It has not occurred to us that the men in the top ranks of the profession, who have been building great engineering works for nearly a lifetime, needed such admonitions [i. e., from practical bridge builders.—Eds.]. And yet that is what the event shows."

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

It is interesting to contrast this attitude of our contemporary with its attitude on the Ashokan Dam controversy. In its issue of Jan. 2, Engineering News, speaking of the Ashokan matters, says:

"If the Board of Water Supply could not rely upon the estimates and opinions of its engineers without conducting a two weeks' court inquiry on every contract awarded, then the Board ought to employ engineers whom they could trust."

The fact is that the Board would not have had to make a "court inquiry" on *every* contract. *One* real inquiry would have sufficed to prove the unreliability of their engineers' estimates as to cost, and their lack of experience in earth work. But the News was then defending "eminent engineers" who had been "building great engineering works for nearly a lifetime," and it had not learned its "lesson of humility" from the Quebec disaster.

The News held the protecting shield of its approval in front of the Ashokan Dam engineers [see Eng. News, Sept. 5, 1907], before the inquiry as to their competency had begun, and referred to them as "the best engineering talent" in the country. In brief, it sought to protect "eminient engineers" from a merited investigation, just as did our other contemporary, Engineering Record.

There is a class of men invariably found on the side of "eminent" men, be they right or wrong, until disaster follows the defense, and their brief lesson in humility is learned.

The real lesson to be learned from this Quebec disaster is not so much a "lesson in humility" as a lesson of courage in defending individual judgment in the face of any man's opinion, no matter how eminent he may be. Had certain engineers and employes on the Quebec bridge had the courage to fight for their judgment as to the weakness of the bridge, instead of permitting a great engineering reputation to silence them, there would have been no Quebec disaster.

To our readers who are young, with reputations yet to make, we say: Many a great reputation is founded on little else than a masterly silence and a look of wisdom. Many another reputation has come from the favor of chance rather than the dower of merit. But, in any event, whether the reputation is merited or not, have sufficient courage to stand for your own convictions, unabashed by the fact that many eminent authorities do not agree with you.

At the close of 1906 there were 2,240 miles of tramways in operation in the United Kingdom, as against 2,117 miles in 1905.

The total railway mileage of the United Kingdom at the close of 1906 amounted to 23,063, an increase of 216 miles over that of the previous year.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Comparative Advantages of Loose Bar and Unit Frame Systems of Reinforcement.*

BY EMILE G. PERROT.†

It is the purpose of the writer in connection with the subject of this paper to explain how to construct a building with unit reinforcement for columns, beams, girders, floor and roof slabs, or, in other words, how to build a "unit reinforced concrete building."

To those experienced in the use of reinforced concrete on a large and extended scale, the uncertainty of each beam and girder (where intended to be the same) being constructed identical in a loose rod system, is very apparent; in fact, it is probable that in any building erected under this system there is no one who would certify to the fact that every piece of reinforcement was in the exact position laid out by its designer, and to go further, it is a question whether in a great many cases all the reinforcing metal shown on the drawings actually enters into the construction.

Is it any wonder then that those engineers whose experience is in steel construction look askance at this new system of construction, when they can see all manner of ways for the finished work to be short of what was really intended? Many such men have advocated the expenditure of a greater sum of money than would be necessary if reinforced concrete were used for a system of construction which would give results of which they were certain. The writer's experience for the past six years convinces him that if the same progress is made in the future as in the past with the use of reinforced concrete for buildings, the use of loose rod systems for beams and girders must be abandoned. The reason for making this sweeping statement is from the fact that as the building regulation of important cities governing the use of this material becomes more thorough and the requirements of the boards of fire underwriters are insisted upon, owners will be obliged to employ the more thorough methods of constructing their buildings, or else suffer a penalty at the hands of the underwriters. To illustrate the point: As a matter of fire protection to the steel tension rods in the bottom of beams and girders, these rods should be located 2 ins. from the bottom of the beam; in other words, there should be 2 ins. of concrete forming an insulation, not ½ in. or possibly 3 ins., as may be the case in a loose rod system. To secure this insulation, some definite means must be used to hold the rods firmly 2 ins. from the bottom of the mold. This is only secured by some positive mechanical means. In loose rod systems the means, as a rule, is altogether wanting, dependence being placed on the concrete for holding the bars in position, or the stirrups are made to form hangers which permit the rods to loosely hang in the form.

If the rods are united into a frame, a suitable chair can be fastened to the bars to support them a definite distance from the bottom of the form. Several systems employ this method. Far better, however, is the use of a socket locking the bars together and bolted to the bottom of the form. This socket can be made to support any number of frames on top of each other, and thus register the position of the bars in regard to their position in the mold as well as to each other.

Another important reason why the rods should be rigidly located in the mold before the concrete is poured is to insure the strength of the beam being the same as that originally figured, for if the bars should be loosely held in the mold, and in the process of tamping be moved farther from the bottom, the insulation from fire would be improved at the expense of the strength of the beam. For instance, in a T beam with a depth of rib of 16 ins. below the under side of the slab, the loss in strength of the concrete beam, due to the shifting of the bars 1 in. further away from the bottom would be almost 7 per cent. Thus it is seen that when an engineer designs a building with beams of a certain depth and the center of action of steel at a definite distance from the bottom of the beam, there is no certainty that his finished beam in the building has the calculated strength, if there has been no means of holding the bars rigidly in place.

Thus a building can be materially weakened by the inaccuracies creeping in on the work, for if there is a loss of 7 per cent by reason of the bars being misplaced, and another 10 per cent loss or possibly more by reason of the concrete not being properly mixed and tamped, the resulting construction, while perhaps appearing to be of the desired strength, would be nevertheless weakened and the factor of safety would be reduced.

---

*Paper read before the National Association of Cement Users, Buffalo, N. Y., Jan. 24, 1908.

†1200 Chestnut St., Philadelphia, Pa.

I have seen a large building constructed of reinforced concrete in which all the floor beams and girders were reinforced with a unit frame, and where these frames were used on the removal of the forms not one bar was exposed to view due to the shifting of the rods. In the same building some unimportant beams in the stairway were reinforced with loose rods, and in one case, after the removal of the forms, a rod was visible, having been pushed out of place in the tamping process. How many other bars have been displaced where the loose ones were used it is impossible to tell.

Thorough tamping of the concrete in the beams and girders is possible only with a frame or where the bars are held rigidly in place. This feature of the work is not always appreciated by constructors, but experiments show that a dense, well tamped concrete is 25 per cent stronger than one not tamped. Hence there is a decided advantage to be gained by using a frame and thoroughly tamping the concrete.

Another phase of the subject of unit systems versus loose rod systems is that a unit system approaches nearer to ideal conditions regarding the erection of a building, eliminating the personal equation as nearly as can be when the placing of the steel is concerned. No part of the reinforcement of a beam or girder can be forgotten or omitted, as the frames are made as a unit in a shop, given a shop number to correspond to the erection plan, and are delivered to the building as a unit and so marked. All the foreman at the building is required to do is to check off the frames as they are delivered, the same as he would steel beams, and see that each frame is placed in the location called for in the erection plans. Thus a floor of frames can be placed a day ahead of the concrete, and when it is necessary to remove the reinforcement from the form, which is very frequently the case, in order to clean out shavings, etc., the frame can be taken out as a whole and reset without much trouble, while if loose rods are used it is very troublesome to take out each bar and stirrups and reset them.

Some may claim that the use of a frame for reinforcing beams is not desirable on account of a lack of flexibility in the frames; since they are made of a specific beam or girder, they cannot be changed or altered without much trouble. This, however, is not generally an objection, for if a change has to be made quickly at a building, as is sometimes the case, it is not necessary to wait for a new frame to be manufactured and delivered; there is still left the recourse of using loose rods for the beam in question, and the building will be no worse off than its neighbor which is constructed entirely of loose rods.

The flexibility of the design of girder frames as made under the original unit patents is as great as any one could wish. Spans as long as 41 ft. have been constructed of girder frames, and likewise heavy cantilever frames.

Another feature of the unit frame is that it can be made of any type of bar, either plain or deformed; as the bars are assembled and held together by the stirrups, it makes very little difference what the shape is.

The latest idea in the design of girder frames is the pin-connected frame, which consists in making a mechanical tie by means of a link from one beam to another, thus making a continuous beam.

The unit idea has been successfully applied to column construction by several designers. The writer has used a unit column of the hooped type for heavy loads, in which the hooping consists of wire rope wound as a helix wired to vertical rods which are secured to bands at top and bottom at intervals of the height. These columns were made in a shop and delivered by team just the same as a steel column, and set up in position with the forms built around them and then filled with concrete; additional longitudinal rods were placed in the center of the column to increase its compressive strength. All column rods are faced on the ends and set in line with those above.

The unit reinforcement for slabs may consist of any fabric or webbing such as expanded metal, wire cloth or even plain rods with cross rods on top and wired together or fastened together with spring stool lock and spacer. These webbings should interlock with the stirrups of the beams and girders. This can be done by having the stirrups long enough to pass up through the mesh of the fabric and be bent over with long pliers so as to hook over the wires of the webbing. In this way the floor slab cannot separate from the beam or girder, and as the greatest horizontal shear is likely to be at this place the interlocking of stirrups and fabric makes a most excellent construction.

It very frequently happens that the standard sizes of fabrics do not give sufficient area of metal per running foot; in these cases additional rods can be wired to the top of the fabric to make up the sectional area which is lacking.

Where a webbing is not used for slab reinforcement, the stirrups should in some manner engage the slab rods.

A bill has been introduced in Congress directing the Secretary of War to have an examination and survey made by a board of engineers of the harbors and rivers of Chicago, the object being to make a complete plan for the improvement of the harbor facilities of that city and the adjacent territory. The survey is to include the Chicago Harbor, the Chicago River, the Calumet Harbor, the Grand Calumet and Little Calumet Rivers, Lake Calumet and its connection with the Calumet River, and the lake shore from the mouth of the Chicago River to the city of Gary, Ind.

Reinforced Concrete in the Construction of Highway Bridges and Culverts.*

BY JAMES MORTLAND.

The one great problem of our roads and highways in the middle west is how they can be made serviceable for the twelve months in the year and be kept up at a minimum expense after time and money have been expended on them.

Along with any road improvement we have the question of bridges across the streams and dugouts.

These bridges must be built across two classes of streams, living streams that flow the year round, and intermittent streams that flow only during the spring months or after heavy rains.

There are several kinds of material for the construction of such bridges. We have to do with:

1. The wooden bridge, with pile bents.
2. Steel frame, or superstructure, on piling.
3. Steel superstructure on masonry abutments, with wood floor.
4. Steel superstructure on abutments, with a concrete floor.
5. Large sewer pipe or tile.
6. Culverts or smooth or corrugated steel pipe, galvanized or painted.
7. Bridges and culverts of reinforced concrete, of any span or shape.

We have now before us seven types of bridges or culverts, all of which have been used on our highways with varying degrees of success.

The suitability of each can best be determined by studying the many conditions which such a structure must undergo.

A bridge or culvert on any highway must necessarily be such as to require little attention or care. It is safe to say that we hardly have a bridge on any of our highways that is regularly inspected from time to time.

Not until a plank in the floor is broken or a washout carries away the filling from the approaches of the bridge or by some condition it is made a dangerous crossing is it inspected or looked after.

In other words, it is necessary to build bridges or culverts that require little care and maintenance.

Now let us consider the use of the wooden bridge in highway improvement. At many places wooden bridges are built over very small streams where the actual span across the stream is very much less, on account of the fact that it is impossible to hold the road leading up to the bridge and to keep the stream under the bridge. I will cite two cases, one where a concrete arch bridge, 35-ft. span, was built to replace a wooden bridge 80 ft. long, the other where a 40-ft. span concrete bridge replaced a wooden structure 66 ft. long.

To hold a wooden bridge in place the piling must be in solid ground, hence we always have so much bridge spanning dry ground, and with the plank roadway there is always the wearing out of the planks, and with that the possibility of having a dangerous crossing.

---

*Paper read before the Nebraska Cement Users' Association.

Speaking of the excessive length of wooden bridges, there is one county in Iowa that has ten miles of wooden bridge floors to maintain, and this county is below the average in the number of bridges.

To make culverts of wood, where any amount of earth is to be placed on top, is temporizing and in the end will cost more to replace.

Bridges with a steel superstructure on piling, with wooden floors, are not much better than the wooden bridges and are of no more use in making our highways permanent than an all wood structure.

Steel bridges with concrete or masonry abutments and with wood floors are not at all so desirable, as the floors rapidly wear out; the life of a plank floor on a bridge with ordinary travel is not more than five years, with many new planks needed from time to time in that interval.

Steel bridges on concrete abutments, with concrete floors, are wholly desirable, but are likewise expensive; in fact, it is possible to construct a concrete bridge as cheaply in ninety-nine cases in a hundred, and the concrete bridge has the advantage of not requiring the painting and suffers no depreciation from the elements.

So far we have considered bridges for living streams or for locations where it would not be policy to narrow the waterway to any great extent. But in this section of the country, in all the middle west, we might say, about one bridge in five spans a living stream, the other four-fifths spanning gullies and dugouts that are dry for a greater part of the year.

Thus we have a condition presenting itself to the highways as it has to the railroads, and we find the railroads have almost invariably constructed such a waterway by means of culverts under their tracks, so as to carry a normal rainfall and filling on top, giving them a continuous roadbed; with a flood, the water may be held back for a time, but soon can get away without any great damage from backing up.

It is possible to adopt this method of placing culverts in such places on the highways, and by filling on top a roadway is obtained that is permanent and with no danger of ever giving out.

By reducing the length of the bridge and placing a culvert the resultant cost of a permanent culvert is oftentimes less than what it would take to build a wooden bridge necessary to span the ditch.

Here are two instances of reducing the waterways, or, rather, of filling up an open ditch: First, where three woden bridges had been built in thirty-five years, the last one was 44 ft. long and it had served its time, so it was removed and a concrete culvert was built with inside dimensions of 4x5 ft., and this culvert has proved ample for all the water that can flow in the ditch.

Another bridge 56 ft. long which had grown from a span of 16 ft. in ten years, was rendered unsafe by the bank slipping in, breaking off the piling. This was replaced with a concrete culvert 5 ft. square and 13 ft. of dirt placed on top, making a permanent roadway instead of having a plank floor over a deep gully.

These two cases show that often there is a plank road where it would be possible to have a dirt road.

Then such gullies or washouts are usually at the foot of a hill or between hills, and the cutting down of the hills and filling in of the culvert improves the whole road and makes a permanent improvement.

Having these conditions, it is well to consider the various materials available for constructing such culverts as needed.

Large sewer pipe has been used with varying degrees of success. Much depends on the placing of the pipe and the character of foundation on which they rest, and in the cementing of the joints.

The disadvantage is in the frequent unequal settling of the pipe when the earth is filled in, and this causes a break in the flow of the water and will tend to fill up the pipe, likewise increasing the chances of undermining the pipe.

To make a concrete footing for the pipe and to carry this up the sides to the horizontal diameter adds greatly to the cost, while it improves the value of the pipe as a culvert.

End walls over the top of the pipe are needed to prevent the fill from washing down into the opening; also wing walls are necessary to hold the dirt on the sides.

The attaching of these walls to the pipe is a difficult matter and is usually very unsatisfactory, owing to the fact of not being able to get a good bend between the pipe and the concrete or mortar of the walls.

There have been many types of circular steel culverts brought into the market in the past few years. All of them seem to have some merit if we can believe the arguments set forth, but all have the same fault in common, the rusting, which is not prevented by any process permanently.

The same objection of attaching wing and end walls to this type of culvert as with sewer pipe is true.

For any given area of carrying capacity it is possible to construct concrete culverts as cheaply as the steel pipe, and the concrete culvert is with wing and end walls.

Having considered briefly about all the kinds of bridges and culverts in use at present, let us now turn our attention to the adaptability of concrete as applied to the problem of making permanent highways of travel for all times to come in so far as this generation and several following generations are concerned.

Concrete is a mixture of cement, sand and crushed stone, so proportioned as to make a dense artificial stone, with no direct planes of cleavage or seams.

It is brittle as stone and can be used to support enormous loads as in foundations, bridges and the like, provided it is so placed as to receive no tension or pull.

With the addition of steel in the concrete to withstand any pull we have a combination of materials excellently adapted for many purposes where stone could not be used.

In an ordinary beam, of any material, the upper surface is in compression and the lower surface is in tension, or the particles of the lower side of the beam tend to separate when a load is applied on the top surface.

The natural arrangement, therefore, in a concrete beam is to design a beam so that the upper portion is composed of concrete, which takes care of the compression, and with steel embedded near the bottom to resist the pull or tension.

The concrete, by surrounding the steel, makes a surer bond between the two materials, and likewise protects the steel from any action of the elements or any other causes destructive to it.

Concrete and steel expand and contract almost exactly the same, so it is safe to use the combination without the possible danger of separation due to any changes of temperature.

To make a safe combination of concrete and steel it is necessary to know just how much load each can stand, and just where the steel must be located to take care of every bit of tension in the concrete.

Then, too, there are other secondary stresses in the interior of the beam, a tendency to slide or shear, and partly a tension or pull, which must be guarded against by properly placing the steel rods. Because of these complications of stresses it is necessary in the designing of bridges and culverts to have a knowledge of these principles in order to make permanent and lasting structures.

Too many culverts and small bridges are being built today that are not in any way permanent, and such work as this will do great harm in the growth of the use of concrete for such purposes. These faulty structures may in some cases be credited to the desire of some one to economize by using too weak mixtures, and in others to the contractor's zeal to make a large profit.

Ignorance of workmen is sometimes the cause of a failure. In no case should a culvert or concrete bridge be built by the cut and try method, for this will frequently show a failure when the forms are removed.

Recently I had occasion to inspect a culvert of reinforced concrete that had been built less than three months and had not yet been subjected to any freezing or heaving due to the frost. This culvert had apparently been built by the foreman in charge without any plans or directions, for it was badly cracked from the weight of the earth load. The fill on top of the culvert was 10 ft. These cracks were generally at right angles to the center line of the culvert, showing that the constructor did not know or paid little attention to the many stresses on such structure. Reinforcing had been left out of the bottom entirely, showing that no attention was paid to the upward pressure on the bottom, which was broken in several places and was heaved up more than 6 ins.

Such designing and construction are in nowise permanent and are as expensive in first cost almost as a culvert built along proper lines.

It is not the purpose of this paper to take up the design so much as the practical principles of construction of culverts and bridges of concrete.

Portland cement should always be used for concrete construction, because it is stronger and more reliable and hardens more quickly than natural cement. The cement should be of a standard brand and not liable to expansion or disintegration, fine and of uniform quality. It should be free from lumps and always stored in a dry place.

For the aggregates in concrete the sand should be clean and coarse, or a mixture of coarse and fine, the coarse grains predominating. It should be free from clay, loam and sticks, organic matter and other impurities.

Screenings or crusher dust from broken stone may be substituted for sand by altering the proportions so as to give a dense mixture and the same relative volume of aggregates.

Gravel when used should be composed of clean pebbles, free from foreign matter, and containing no clay or any material adhering to the pebbles. It should be screened to remove the sand and should be mixed afterwards in the proper proportions. However, if by test the gravel runs in the proportions of two and one-half to three parts of sand to from four to five parts of pebbles, it can be used without screening.

Broken stone should consist of pieces of hard, durable rock, such as trap, granite, limestone or conglomerate.

The water used in mixing should be clean and free from acids or strong alkalies.

Steel for reinforcing should be of high tensile strength and of such shape as to form a firm bond with the concrete.

In mixing concrete for the construction of culverts and bridges the proportion should be such as as to give the densest concrete with the maximum strength of the cement mortar.

The mortar mixture of sand and cement is generally two parts of sand to one of cement, yet I have used two and one-half and sometimes three parts of sand and obtained a mixture that proved dense and for walls and footings proved as good as the two to one mixture.

The stone aggregate in the proportion of four parts will in most cases make the most desirable mixture, as it allows for enough mortar to surround all the stones and leaves no stone pockets in the concrete surface.

Mixing concrete is a vital thing in the strength of a structure, whether large or small. "Mix well and mix wet" should be pasted in every man's hat on the work, and by so doing many faults will disappear.

Exposed surfaces of concrete may be made sufficiently smooth by spading, so as to force the stones back and the mortar to the surface of the forms. The forms should be sufficiently tight to prevent the mortar running out. With these precautions surfaces can be obtained that require very little patching or plastering to make a neat job.

The forms should be made of lumber sufficiently strong to hold itself in line without an excess of bracing, and not bulge or be thrown out by the workmen filling them. All exposed surfaces should be made with dressed lumber. All joints should be fitted neatly. The lumber best adapted for building the forms for culverts and bridges is 2x6-in. stuff dressed and with 4x4 ins. for the stays. The handiest ties are ½-in. bolts of a length necessary to hold the forms together. With care in removing them they can be used several times. Bolting the forms requires few nails and makes a form that can be easily taken down. Then it is possible to get the wall of the required thickness and be assured it will not bulge out of line or shape.

The time necessary to leave the forms in place varies considerably with the weather. But under ordinary circumstances wing walls and culvert sides can be removed in three days.

Slabs of not more than 6-ft. span may be removed in five days. Long arch spans and slabs require no less than ten days of good drying weather. In freezing weather the forms should be left in place as long as possible.

Reinforced concrete culverts can be constructed successfully for all spans up to 15 ft. and give perfect satisfaction. They should be designed to carry the maximum earth load that could be put on top, as in the grading and leveling the roads would sometimes make an increasing earth load from year to year.

The wing walls should be at least 10 ft. long if the earth fill is more than 5 ft. and an end wall should always be high enough to prevent the dirt from spilling over into the waterway of the culvert.

The wings should in all cases be placed at an angle of 30° with the center of the culvert.

End walls across the top of the culvert should be no less than 4 ft. high, and if the fill is more than 8 ft. they should be 6 ft. high. The higher the wing and end walls the wider the width of the roadway.

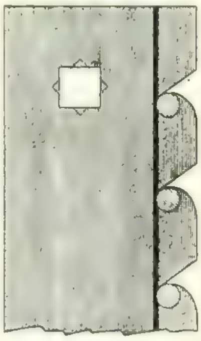
Bridges of spans greater than 15 ft. and up to 30 ft. should be with concrete girders. Spans greater than 30 ft. should be arched.

The design and construction of the concrete bridges should always be in the hands of competent engineers and workmen.

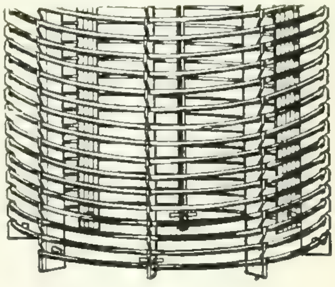
With concrete bridges we have something that improves with age and is as permanent as anything can be. All that is needed to make them so is the use of the best material, good workmen and designs that have the approval of engineers versed in the work.

A New Unit Hooped Column Reinforcement.

The accompanying cuts show the details of a hooped reinforcement for concrete columns made by the F. P. Smith Wire and Iron Works, Chicago, Ill., and being used for some 4,000 columns in the large new warehouse of reinforced concrete being built for Montgomery Ward & Co., at Chicago, Ill. The construction of this building was described in our issue of May 29, 1907. The reinforcement, as shown, is made up in units of any length and diameter and of any shape bar and size of hooping specified. Ordinarily, the bars used are plain flats with rounded edges, as shown, and four bars are used. The bars are fixed to rotating heads and the hooping wire wound into the rounded holes which are then closed by a hammer blow on the projecting fin or point. The pitch of the hooping is made anything desired.



Connection of Hoops to Verticals.



Hooped Column Reinforcement.

The grand total of excavation on the Isthmian Canal during February was 2,945,880 cu. yds. There were 24 working days in the month.

The Isthmian Canal Commission has extended the time for opening bids for furnishing 4,500,000 bbls. of Portland cement from March 12 to April 13.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Method of Building the Tunnel of the Detroit Water Works.*

BY JAMES RITCHIE.

During a part of the years 1904 and 1905 the writer had charge of the construction of the tunnel and river shaft of the Detroit water works, representing the contractors, The C. H. Fath & Son Construction Company of Cleveland. The work was designed and the construction superintended by Mr. C. W. Hubbell, chief engineer of the Detroit waterworks.

Before making a contract for this work the city of Detroit had built a tunnel from the pumping station to a point near the bank of the Detroit river, a distance of about 1,000 ft., and had constructed a gate chamber and a shore shaft with 50 ft. of river tunnel. This work was done with their own men by day labor and without the use of compressed air. The shore tunnel was 10 ft. inside diameter and was placed with its axis at a distance of 26 ft. below the surface of the ground. The shore shaft had an inside diameter of 10 ft. and a total depth below the surface of the ground of 78 ft., 6½ ins. The axis of the river tunnel was at a distance of 69 ft. below the surface of the ground, or 63 ft. below the surface of the water in the Detroit river. The inside diameter of the river tunnel was 10 ft., and the tunnel was constructed of four rings of shale brick laid in Portland cement mortar. The diameter of the excavation was 13 ft. After completing the first 50 ft. of the river tunnel, the city put in a timber bulkhead and prepared to let a contract for the rest of the tunnel, the river shaft and the intake crib and crib house.

The contract for the river tunnel and shaft covered 3,185 ft. of tunnel from the end of the 50 ft. built by the city to a point 75 ft. beyond the center of the intake crib, and a river shaft of 10 ft. inside diameter placed at the center of the crib. The end of the tunnel was finished by two bulkheads 25 ft. apart, to permit of a second crib and shaft being constructed should it be determined to extend the tunnel.

The power plant consisted of two boilers, one Ingersoll and one Rand air compressor, each 18 x 24 ins., one electric generator and engine for operating same, one elevator hoisting engine, two drainage pumps for removing water from the tunnel and one boiler feed pump. The only part of the plant not in duplicate was the electric lighting, and to provide for emergencies the city lighting plant was connected to our tunnel line by a special switch.

Compressed air was furnished to the face of the work through a 5-in. pipe, which was carried along as the work progressed, and the end of which was at all times within 50 ft. of the working face. Water was carried to the face through a 2-in. pipe and kept close enough to the work to supply the mortar boxes through 25 ft. of hose. Electric light wires and telephone wires at all times extended to the face and maintained light and communication. The telephone gave us the most trouble, as the instruments could not stand the atmospheric conditions for any great time without repair, but they were well worth any trouble that they caused us.

Each Sunday the tunnel was thoroughly cleaned and ventilated, wires overhauled, telephone adjusted and other necessary work on the plant performed, ready for the night shift to go on at 11 o'clock. There were two shifts of miners, one going on at 11 p. m. and the second at 7 a. m. The bricklayers went on at 3 p. m. and bricked up what had been excavated by the mining shifts. For about 1,000 ft. after the air locks were placed, the pressure was 8 to 10 lbs.; for the second 1,000 ft. it ran from 10 to 20 lbs., and for the rest of the tunnel from 20 to 27 lbs. At one point where bad ground was encountered, the pressure for about 12 ft. of working distance was 37 lbs. The tunnel was completed as far as the location of the river shaft, and the sump under same was then built, after which the remaining 75 ft. of tunnel and the two end bulkheads were constructed. The entire time occupied in constructing the tunnel was 9½ months from the first laying of brick, or an average of about 335 ft. per month, but from June 14 to August 1, 1904, we only built 200 ft., being delayed by putting in the air locks and scarcity of brick, the latter coming very slowly at first. In the month of January, 1905, we built 454 ft. 4 ins., during which we reached our maximum of one day's work, namely, 21 ft. 2 ins., on January 23; 20 ft. 3 ins., on January 16; and an even 20 ft. on January 9. Our average during the month of January was 17 ft. 6 ins. per day.

The mining shifts consisted of one foreman, four miners and six muckers in each shift, also two drivers and one lock tender.

The first mining shift excavated the top half of the tunnel to such distance from the end of the brickwork as the foreman considered could be bricked up in 8 hrs., and then took out as much of the bottom as they could in the remainder of their shift. Before commencing their excavation they had to strike the centers and put in the floor and track through the section of tunnel completed by the last shift of bricklayers.

The second mining shift completed the bottom and trimmed the circle and set in place the form for the invert. The reason that it requires more time to do the second half is on account of the men having to lift a large part of the material from 3 to 5 ft. to place in the cars.

The bricklaying shift consisted of four bricklayers, six to eight helpers, two drivers and one lock tender. The number of brick to the foot being about 825, it will be seen that our average for the month of January of 17.5 ft. meant the laying of about 14,440 brick in 8 hours, or 3,610 brick by each man. This means from 7 to 8 brick per man per minute, and when it is remembered that the keying up of the arch can only be done by one man, and that it ordinarily requires from 45 minutes to one hour to key up, it will be seen that in laying the bottom a much faster rate must be kept up. Besides this the centers have to be set requiring from 20 to 30 min., which again operates as a delay. The maximum day's work of 21 ft. 2 ins. was laid up by the bricklayers in 9 hours, and required 17,464 brick, or an average per man of 4,366.

The men outside the air lock were divided into two shifts of 12 hrs. The day shift consisted of one engineer one elevator man, one driver, and from two to four laborers. The night shift consisted of one engineer, one fireman, one driver and two laborers. The arrangement was as above until we found it necessary to make three shifts on top, leaving only the engineer, fireman and elevator man on twelve-hour shifts.

Mules were used for hauling the excavated material out of the tunnel to the air lock, from which it was taken on the elevator to the surface and again hauled by mules out on the dump. The month in which we made the best record was full of snow and sleet storms which impeded us in handling the material on the dump, and also in delivering materials into the tunnel. The latter work was done in the same manner as the removing of the earth, namely, by means of mules. The cars used in hauling earth were so made that the sides and ends being removed they were suitable for hauling brick. Also there were boxes provided in which the cement and sand were mixed dry and thus sent into the tunnel on the cars, the mortar being wet and mixed in boxes at the face of the work. The mules changed shifts with the men, and went in and came out after a few trials as easily as any one.

As early as 1663 Boston, Mass., had streets paved with pebbles.

---

*Abstracted from a paper in the Journal of the Asso. of Eng. Societies, Vol. XXXIX.

A Protest Against Government Ownership of Dredges.*

BY WILLIAM P. RYAN.†

The present policy of the War Department to make the government ownership of dredges a fixed administrative principle is not only destructive of a large and important private business, but is, we believe, absolutely illegal. It is doing by indirection what would never be dreamed of as a governmental policy, if the people were permitted to pass upon the question and were able to see its serious consequences as, in the last analysis, it is rank socialism.

Historically speaking the competitive system has been the vitalizing principle of our national life. Full and unhampered freedom of the individual to use his talents to the best possible advantage has been our distinguishing characteristic and has been the paramount stimulus to all our energy, industry and ingenuity. This individual liberty, with the wonderful division of labor that it has made possible, alone explains our industrial and commercial supremacy, and the establishment of our great transportation facilities that are the marvel of all mankind.

Nor have our people failed to formulate their opinion into statute law, for the several states, within their respective jurisdictions, by their anti-consolidation legislation, and the Congress of the United States, through the Sherman AntiTrust law, have unmistakably expressed the American people's adherence to the competitive system and against so-called consolidation that really spells monopolistic socialism.

Monopoly, whether governmental or otherwise, is the antithesis of individual initiative, and consequently can never survive in this country, as it is essentially socialistic.

With the controlling incentive for personal compensation removed it is not reasonable to suppose, in the face of all experience, that the same zeal and untiring energy displayed under private ownership, will be extended and sustained in the governmental plan, and hence the efficiency of labor will never reach the degree of intensity under the latter as under the former condition, with the result that the cost of all governmental work will be appreciably greater than by private contract even after including a reasonable profit to the contractor.

In support of the position, above taken, that, generally speaking, the cost of all governmental work will be appreciably greater than by private contract I beg to submit, as specimen cases, taken from widely separated sections of the country the exhibits marked A, B, C and D, which show conclusively the correctness of our contention:

A......St. Johns River, Fla.
B......Sabine Pass, Texas.
C......Galveston, Texas.
D......Schooner Ledge, Del'w're river.

To which could be added, we are sure, many others, if the published reports of the Army Engineers were sufficiently enlightening to enable us to verify their system of accounting.

There is another reason, fundamental in its nature, why dredges, under Government ownership, can never be as economically administered as under private direction, and this entirely independent of political considerations.

It is this: Talent is rarely manifold in any one individual, and barring perhaps a Michael Angelo, genius never. It would be an exceptional case to see an individual both poet and architect, or sculptor and industrial captain, and it follows, as a corollary that capacity for successful dredging and distinction in professional engineering would be seldom united in one man.

Experience is the great teacher in dredging operations as well as in the sciences and arts. The skill acquired in successfully conducted dredging is largely of mechanical origin, and can only be obtained by actual daily contact after years of continuous service. It is a business which cannot be managed by theoretical supervision, at long range, be the supervising head never so profound in mathematical knowledge or general educational attainment. To be frank about it, it is solely a practical problem absolutely independent of professional eminence, and by its very nature can offer no inducements to, nor inspire enthusiasm in any engineer who would find its pursuit inconsistent with all his life's training.

Besides we candidly confess the ambition of the practical dredger is purely utilitarian in its nature—to make money whilst that of the army engineer is to obtain distinction in preserving the ideals of his honorable calling. Each content with his respective occupation and each influenced by the motive underlying his labors, which in the very nature of things will have economy as his guiding principle? To ask the question is to answer it.

With the one devoting his life to the acquisition of property, and the other, by the ethics of his profession forswearing its accumulation, it is not difficult to realize the soundness of my contention that to the practical dredging man belongs the primacy in this field of industry, and there he should be left free to toil undisturbed and unmolested by Government competition, but, subject, however, always to proper regulation and control.

Nor should sentimental reasons be considered in justification of the establishment of this un-American innovation, such, for instance, as the fear that because there have been private contractors morally delinquent, government ownership of dredges will prevent a recurrence of such lapses from rectitude. For it is sufficient to say that in reply to this view a parity of reasoning would apply with equal force to the Government itself, since there could not have been a Green or Gaynor if there had not been a Carter.

That an industry representing as it does, from twenty to thirty millions of invested capital, and which has been a most useful and powerful agency in developing harbors and waterways of our country, at a reasonable cost, should be selected for ultimate destruction is beyond our comprehension.

If the movement inaugurated by the War Department for the construction of dredges be continued, it will not be long before we will cease to exist as one of our principal American enterprises. For with what hope of success can we engage in the unequal contest of competing with the greatest Government on earth with its unlimited resources.

This statement of our probable early extinction is not a mere idle vaporing of the imagination, but an intensely stubborn fact, which becomes quite obvious, when it is understood that the Government, as of date June 30, 1906, owned 128 dredges of various types, carried at an estimated (not cost) value of $6,148,000.00, all of which are exclusive of the additions made in the fiscal year ending June 30, 1907, and the plant assembled on the Isthmus of Panama for the construction of the canal connecting the two oceans.

Whilst we are willing to concede that in exceptional cases, where bars and shoals are formed with great uncertainty and rapidity, and navigation is consequently unexpectedly obstructed, the Government is justified in having its own equipment, in such localities, for such emergencies, yet we are unalterably opposed to the utilization of Government dredges in competition with the private contractor, in any instance, where the latter can efficiently and at a reasonable cost perform the work, and particularly under such circumstances as now exist on the Delaware River project, of the city of Philadelphia, where the U. S. Engineer, with the sanction of the War Department, has undertaken to do the dredging for the municipal government at the actual cost of wages and supplies, and without any reference to plant investment much less a legitimate profit.

There is one important consideration germane to this discussion upon which I wish to rivet your attention, and which, I may say, incidentally, pays eloquent tribute to the liberality and progressiveness of the dredging interests of the United States, and it is this: That notwithstanding the prices of labor, material and supplies have been *steadily advancing* for the past decade the unit cost of dredging to the Government has been *gradually declining*, a condition that can only be explained by the fact that our mechanical engineers have been stimulated to the highest expression of ingenious skill, and that the dredge owners of the country have made liberal investments of capital in these improved and more efficient machines, thereby countervailing the efforts of a sustained upward movement in general prices.

---

*Abstracted from an argument presented before the Rivers and Harbors Committee.

†Secretary Dredge Owners' Protective Assn., Baltimore, Md.

In confirmation of which I need only say that the average price of dredging of the channels leading to Baltimore from 1871-1896 (25 years) was 13.44 cents per cubic yard, whilst the contract for making them 30 ft. deep in 1899, and extending them to 35 ft. in 1905 and 1907, were 8.33c, 6.45c, and 8½c, respectively, or an average for the past nine years of 7.76 cents per cubic yard or 42¼ per cent. less than for 1871-1896.

Nothing that we have said is weakened by the apparent advance of the modern movement towards the municipalization of what are popularly termed—public utilities. Because the public agencies involved in this question—the lighting, water and street railway systems—are natural monopolies, exclusive in their nature and standing apart from the well recognized field of private endeavor. They depend not on individual initiative, but the *exclusive privilege of the enjoyment of public highways, and the accident of a congested population within the corporate limits of the municipality granting the franchise.* In other words the line of demarcation is positively drawn between a theory of municipal ownership that may be tolerated, or even encouraged, and one that infringes upon that well defined sphere of private enterprises that must be preserved if equal justice is to be done our citizens under our laws and institutions.

Indeed the picture drawn by Senator Lodge in his recent Brookline address graphically portrays the results of the adoption of this alien idea when he says: "Government ownership . . . would mean in its fulfillment the destruction of the institutions we have known and loved and under which our liberties have been won and preserved. We should have an oligarchy composed of a few officeholders, a despot at the head and all below on one sordid level."

The Shrinkage of Earth in a Colorado Reservoir Dam.

In a paper, read before the Western Society of Engineers, on the Sugar Loaf reservoir, owned by the Colorado Fuel & Iron Co., by R. M. Hosea, Chief Engineer of the company, some data on the shrinkage of the earth work are given.

The entire area of the dam site was overgrown with willows and some trees, and in the lowest portion was covered with 1 or 2 ft. of black muck. All of this was moved, giving a firm clay foundation for the earth work. The surface was benched and furrowed. Borrow pits were laid out on the inside of the reservoir site over a large area and stripped of all vegetable matter, exposing the clay sand mixture, containing some boulders, beneath which was a clay sheet four or more feet thick. The cross section of the reservoir dike was about 200 ft. on the base,. 25 ft. on the top, with a height of about 40 ft. The inner slope was 3 to 1, while the down stream slope was 2 to 1.

The base was made of moist clay and well puddled. Around all pipes and masonry this clay was placed by hand and tamped. The up stream face was made for a thickness of 20 ft. of the best clay obtainable, the center of the dike prism being of selected material, while the poorest material was all placed in the down stream face. The dam was carried up in thin layers. The whole was smoothed, sprinkled and rolled with a heavy Springfield roller. The formation of layers was carefully avoided by depositing loads irregularly.

Elevating graders were tried for a time, but the presence of boulders made their use inadvisable, consequently a small steam shovel was used to load into wagons, the material being deposited in that manner.

There were 95,388 cu. yds. of earth excavated for the dam prism, while the actual cross section of the dam showed 90,200 cu. yds. The dam remained partly completed through one winter, which gave the embankment a chance to become compacted. Throughout the entire work it was sprinkled and rolled. These figures show a shrinkage during construction of 5,188 cu. yds. or 5.44 per cent. Mr. Hosea does not state that any tests have been made to show settlement of the dike since the reservoir has been in use.

Diagram for Determining Percentages of Different Sizes of Stone Delivered by Rock Crushers.

The accompanying diagram, prepared by the engineers of the Power & Mining Machinery Co., Cudahy, Wis., shows the percentages of different size stones produced by rock crushers. The company has used this diagram extensively and has found it very reliable. By compiling a large number of data it was found that the results from different machines were uniform, so that this diagram can be used to determine the proportions in the products of jaw crushers and rolls as well as of gyratory crushers. The following is a description of the diagram and of the method of using it:

The horizontal lines represent the different sizes of perforations in the screen, the vertical lines indicate the percentages of material which will pass through the screen. The diagonal lines were drawn through the points taken from the tabulated data, so that the intersections of the diagonals with the horizontal and vertical lines show the percentage of that size material in the product of the crusher to which the diagonal corresponds.

It was found that crushers will make less fines if they are set so that 15 per cent. of the product is larger than the required size. This over-size is usually recrushed by returning it to the same machine or to smaller breakers. The intersections of the diagonals were therefore made with the horizontals coming exactly on the vertical representing 85 per cent so as to make the diagram more readily applicable to the usual adjustment of crushers. The diagonal corresponding to any adjustment or setting is found passing through the intersection of this 85 per cent. line with the horizontal corresponding to the same size of screen.

To determine how much material will pass through a 1-in. screen when the crusher is adjusted for a 2½-in. screen find the horizontal marked 2½, follow it to its intersection with the heavy line marked 85 per cent. The diagonal passing through this point is the diagonal corresponding to a 2½ adjustment, follow this diagonal till it intersects the horizontal marked 1 in., the vertical through this point is 31, hence 31 per cent of the material will pass through a 1-in. screen, similarly 67 per cent of the material will pass through a 2-in. screen. The percentage that is coarser than 1 in. and finer than 2 ins. is found by subtracting one percentage from the other, and in this case is equal to 36 per cent. The lines to be followed in this problem are indicated heavy for clearness.

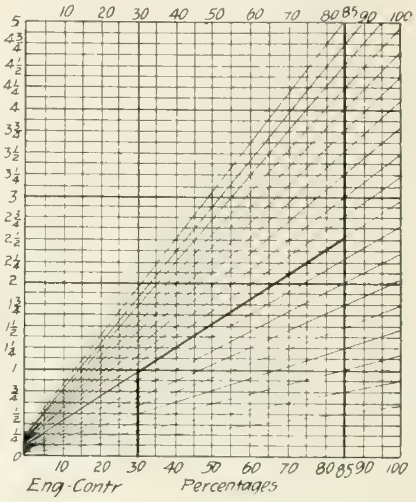


Diagram for Determining Percentages of Sizes of Stone.

In case the material has already been screened through a certain perforation, the diagonal should be selected on the 100 per cent vertical line instead of 85 per cent line, because there are no rejections in the mass.

Dijin, France, had paved streets as early as 1301.

In 1719 many of the sidewalks of Philadelphia were paved with brick.

The Board of Local Improvements of Chicago, Ill., is planning to spend $5,000,000 this year in street improvement work.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

The Binder Course in Asphalt Paving.*

BY J. G. GABELMAN.†

This binder course should be stable so that it will not push out of shape under the action of the roller or be displaced by traffic, so that it will support a top course under the heaviest loads without vibration. It should be of such nature that the asphalt course will adhere to it and thus prevent the wearing surface from being displaced or pushed out of shape by traffic. It should be composed of a hard and durable natural stone which will not crush under heavy loads and which will not be affected by the temperature to which it is necessary to heat it before mixing with the asphaltic cement. This stone should not contain large voids, as these will cause the asphaltic cement to stand out in patches which may be displaced, or the wearing surface forced into these voids, causing failure of the pavement.

A clean, hard and durable broken stone, of varying sizes, should be used which will pass a 1¼-in. screen and be held on a ¼-in. screen. Enough torpedo sand should be added to fill the voids, left in the stone, after compression under the roller.

A binder, as above suggested, will support the wearing surface under heavy traffic and the use of a finer material to fill the voids in the stone is not considered necessary.

In place of sand, screenings from the broken stone may be used, but sand is preferable for the reason that the larger particles, in the screenings, are flat with sharp edges, which are easily crushed or broken.

The writer is of the opinion that the use of reduced old surface mixtures to fill the voids in the stone is not economical. Even when used to fill the voids in crusher run stone its use is not considered economical. In the case of Chicago limestones, when the crusher is set for binder size about 17 per cent of the stone entering the crusher comes out in the shape of screenings. Thus for 83 parts of broken stone we have 17 parts screenings, or for 100 parts broken stone about 20 parts screenings. Tests made by the writer show that about 50 per cent of these screenings, or a quantity equal to 10 per cent of the volume of the broken stone, will pass through a 10 mesh sieve. Assuming that the broken stone contains 48 per cent voids, to fill them we would have to add to the 20 per cent screenings already mentioned 28 per cent of reduced old surface mixture sand, which will all pass a 10 mesh sieve. Taking the screenings which will pass a 10 mesh sieve, a quantity equal to 10 per cent of the volume of the stone and the 28 per cent of same from the reduced old surface mixture it will be seen that a quantity equal to 38 per cent of the stone will pass a 10 mesh sieve. These tests also show that of the sand and screenings a quantity equal to about 19 per cent of the volume of the stone will pass a 50 mesh sieve. This is a larger proportion of fine material than is advisable.

When stone of a single size is used and the voids filled with reduced old paving mixture there will be a still larger proportion of fine material. Assuming that the stone contains 48 per cent voids, these will be filled with a material passing a 10 mesh sieve. About 60 per cent of this reduced old paving mixture, or a quantity equal to 29 per cent of the volume of the broken stone will pass a 50 mesh sieve. It will be seen that such a grading from the large stone to the fine material filling the voids without intermediate sizes is not well balanced. Such a binder would not be as rigid as one in which there is a uniform variation in size from the largest particle to the smallest, and consequently such an excess of fine material must detract from the stability of the binder. Such a binder, when rolled, presents a surface similar to the old cushion coat of former years. There is some doubt as to whether the wearing coat would adhere to such a surface. If the top course could be laid while the binder is still very hot they would very likely adhere, but after the binder has cooled and especially in dry weather when dust is blown over the surface it is very doubtful if the wearing course would adhere. It may become smooth under the roller, but if there are spots where the two surfaces do not perfectly adhere there will be a tendency for the wearing surface over these spots to "creep" in the direction of traffic and the surface become wavy.

A close binder should be laid, but why fill the voids with a too large proportion of fine material which detracts from stability, is likely to cause an imperfect adhesion, and increases the cost by requiring more asphaltic cement to coat the particles?

Sight is not lost of the fact that in our larger cities the time is fast approaching when a large area of asphalt paving will have to be resurfaced each year. If no use can be made of the old paving mixture it will have to be consigned to the dump. Necessity being the mother of invention, who may say that some day it may not be practical to have a plant in each of our largest cities to treat these old paving mixtures, extracting the bitumens and leaving the sand to be used over again.

The binder after being thoroughly compacted should have a thickness of not less than 1½ ins. If economy is aimed at, it would be better to reduce the thickness of the wearing surface.

The asphaltic cement should be of the same kind and quality as that required in the paving mixture, except that its penetration may be higher. If it is important to have the particles of stone properly graded as to size it is also important to have them well cemented together. The asphaltic cement should be mixed with the stone in such proportion that each particle will be coated without producing an excess of cement. The stone before being mixed with the asphaltic cement should not be heated to a temperature so high that the cement will not adhere to it. Limestones found in the vicinity of Chicago should not be heated to a temperature higher than 275 degs. F. Some limestones found in the vicinity of Chicago should not be used at all.

The best white limestones are hardly fit for use on streets where there is heavy traffic, but soft, partly disintegrated and weather-worn limestones should be omitted entirely.

In looking over the specifications of our larger cities it will be seen that there is no uniformity in the manner of laying binder. Some cities are laying a large open binder, while others are laying an exceedingly close, I might say tight, binder. Some cities specify binder of a uniform thickness of 1 in., while others require 1½ ins. There is also a wide range in the temperature to which the stone may be heated before being mixed with the asphaltic cement. About the only thing on which there appears to be no difference of opinion among the engineers who got up these specifications is the clause, "should the binder appear dull from overheating or lack of cement it will be rejected."

The engineer in charge of the Georgian Bay Canal survey has submitted to the Canadia Parliament a report of the year's work, which was largely confined to the French River between Georgian Bay and North Bay, a distance of 31 miles. According to the report, the approximate estimated cost of the canalization of the French River is $14,000,000. The plan of the canal contemplates a ship canal of a depth of 22 ft. and provides for the erection of three reaches between Georgian Bay and Lake Nipissing by means of locks and dams, the lift of the locks varying from 22 to 24 ft. In general, the proposed route of the canal is practically a chain of deep lakes or wide river expansions, so that the construction of the canal would involve the canalization of only 275 miles, leaving 357 miles of free navigation.

---

*Abstract of a paper read before the Illinois Society of Engineers and Surveyors.

†Division Engineer Board Local Improvements, Chicago, Ill.

The Average Unit Cost of Pavement Laid in 1907 in Representative Cities, Together With the Wages of Labor and Cost of Paving Materials.

In our issue of March 27, 1907, we printed a number of tables showing the character and cost of paving work done in 1906, in a number of representative American cities. In the present issue we are able to present somewhat similar data on the paving work done in 1907 in 100 cities of the United States. No attempt was made to get complete statistics of the United States; the purpose, rather, was to select cities in various sections of the country on the assumption that their practice and activity would represent with approximate accuracy the practice and activity of these sections as a whole.

It will be noted from the tables that much paving work was done the past year and the forecast for 1908 shows that much work is proposed for the present year. The forecast is by no means complete, for many cities, which will undoubtedly do considerable work this year, failed to report on the question, and some cities that did report stated that estimates for the current year had not yet been made up. It is probable that the amounts of paving and sewer work will be fully up to that done last year.

Perhaps the most interesting of the tables is the one showing the wages of labor and the prices of materials. It will be noted from this that the eight-hour day does not prevail in all of the cities reporting. Practically all of the eastern states have an eight-hour day, while in the middle west the 10-hour day seems to be the more common. The rates of wages of labor vary, being lowest in the south and highest in the west. In the New England cities the wages of common labor averaged $2.00 per day, while in the middle west the average was $1.75. The cost of the various paving materials taken in combination with the cost of labor are interesting in as much as they show in a measure the reason for the variation in the cost of the pavement given in the other tables.

The tables giving the cost of the various kinds of pavement should be of general interest, although it is evident that no just comparison can be made without going far deeper into local conditions than the data sent us would permit. In these tables the average price per square yard includes grading, unless stated otherwise.

TABLE SHOWING AMOUNTS OF PAVEMENT AND SEWERS CONSTRUCTED IN 1907 IN 100 CITIES AND AMOUNTS OF PROPOSED WORK FOR 1908.

	PAVEMENT				SEWERS			
	Laid in 1907		Forecast for 1908.		Laid in 1907		Forecast for 1908.	
	Miles.	Cost.	Miles.	Cost.	Miles.	Cost.	Miles.	Cost.
Albany, N. Y.	3.4	$ 112,160	3.4	$ 112,160	3.1	$ 48,102	3.1	$ 48,102
Allentown, Pa.	2.56	103,383	1.4	58,600	...	....	...	....
Ann Arbor, Mich.	1.5	19,092	...	....	3.3	15,079	3.	....
Atchison, Kan.	1.3	25,522	.83	15,244	2	21,486	.8	2,583
Battle Creek, Mich.	9	29,278	75	27,000	2.5	29,072	1.5	25,000
Bay City, Mich.	...	12,300	2.5	50,000	...	34,281	5.	15,000
Bayonne, N. J.	.87	30,169	2	100,000	1	14,827	1.5	35,000
Beaumont, Tex.	1	20,460	...	75,000	2.75	75,000	...	....
Binghamton, N. Y.	1.66	74,413	...	15,000	2.12	25,977	..	20,000
Bridgeport, Conn.	.85	62,864	...	....	2.62	26,848	...	....
Brockton, Mass.	2.6	....	...	35,000	5	....	..	40,000
Buffalo, N. Y.	11	421,522	...	....	6.75	74,322	...	....
Butte, Mont.	.2	29,645	.5	65,000	2.4	30,733	2	50,000
Cedar Rapids, Ia.	1.1	46,180	.45	18,244	..	....	...	....
Charleston, S. C.	.5	8,453	...	65,000	.	....	...	....
Charlotte, N. C.	...	....	3.5	84,200	1.25	2,374	.	....
Cheyenne, Wyo.	..	....	...	....	.5	2,753	...	....
Cleveland, O.	29.7	1,033,196	40.5	1,705,747	28.5	755,759	18	400,000
Clinton, Ia.	.	....	.11	5,100	4	170,000	13	180,000
Columbus, O.	10.2	581,000	20	850,000	...	....	...	....
Council Bluffs, Ia.	1.8	75,787	4	150,000	4.9	16,788	2.5	..
Dayton, O.	8.77	248,995	5	150,000	.	....	...	.....
Denison, Tex.	.25	9,349	.75	28,048	..	....	...	..
East Liverpool, O.	1	11,325	3	79,600	..	....	...	....
East St. Louis, Ill.	4	98,213	5.75	164,968	4.7	21,185	7	752,246
East Orange, N. J.	2.71	....	...	....	2	15,817	...	....
Elgin, Ill.	1	45,173	2.6	141,180	23.5	121,616	12.25	129,500
Elizabeth, N. J.	2.15	....	...	....	3.14	....	...	....
Elmira, N. Y.	5	23,348	.28	15,000	3.07	13,682	1.25	6,600
Evanston, Ill.	4.71	135,950	...	.....	1.84	20,197	...	......
Everett, Mass.	...	....	...	....	.28	1,891	...	....
Fond du Lac, Wis.	7.25	166,644	8	150,000	12	73,000	2	10,000
Fort Dodge, Ia.	...	....	...	....	2	1,342	.5	2,610
Fort Wayne, Ind.	3.66	151,573	3	130,000	2.3	11,539	2	31,000
Gloversville, N. Y.	...	....	...	....	2	15,424	.4	......
Grand Rapids, Mich.	4.71	66,022	4.53	48,775	...	......	...	....
Great Falls, Mont.	.423	64,969	.06	8,000	.33	4,516	1.5	17,000
Harrisburg, Pa.	8.93	310,924	8	278,543	4.24	74,711	4	74,700
Haverhill, Mass.	.1	2,975	...	....	.5	7,059	.63	7,800
Holyoke, Mass.	2.02	45,666	...	....	1.13	13,000	...	......
Jamestown, N. Y.	.67	27,432	1.15	42,640	2.13	11,525	...	....
Jersey City, N. J.	4.89	226,429	2	90,400	3.04	83,347	3.7	485,173
Joliet, Ill.	...	....	1	37,000	1.72	21,536	3.9	67,455
Kansas City, Kan.	.12	2,775	3	16,000	...	....	...	....
Keokuk, Ia.	.7	16,615	.8	16,000	.14	3,100	.25	5,000
Knoxville, Tenn.	4.1	164,550	5.1	200,000	6.9	30,200	5	25,000
La Crosse, Wis.	2.69	66,615	1.36	33,539	2.25	23,754	...	....
Lansing, Mich.	1.3	....	...	....	7.6	58,108	...	....
Lawrence, Mass.	.9	....	...	....	1.15	60,233	...	......
Marion, Ind.	1.04	34,812	...	....	.4	1,460	2.25	28,700
Medford, Mass.	3	43,500	...	....	1.22	6,450	...	....
Meriden, Conn.	...	......	...	....	.15	9,998	...	......
Meridian, Miss.	...	.....	4.5	250,000	4	10,750	...	......
Middletown, N. Y.	.5	12,000	...	....	.6	3,500	...	....
Milwaukee, Wis.	10.9	317,000	12	400,000	13.4	301,982	13.4	300,000
Minneapolis, Minn.	11.2	404,815	11.2	350,000	12.8	195,400	12	200,000
Moline, Ill.	1.75	71,257	1.5	54,000	1	28,397	5.50	31,000
Muncie, Ind.	.33	....	1.25	....	.8	6,230	.75	5,500
Nashville, Tenn.	9.66	......	12	90,000	5.56	38,167	4	....
New Albany, Ind.	3	166,814	...	....	...	....	..	....
New Bedford, Mass.	3.64	49,775	...	....	3.86	58,272	...	....
New Brunswick, N. J.	3	80,000	.5	40,000	...	....	...	....
New Castle, Pa.	3.13	74,997	1	....	2.86	15,784	2	....
Niagara Falls, N. Y.	6.01	315,638	...	......	4.69	57,234	...	....
North Adams, Mass.	...	......	..	......	.84	7,000	..	....
Oshkosh, Wis.	3.7	175,317	2	57,000	3.14	27,054	4	60,000
Pawtucket, R. I.	1.07	......	...	....	1.49	21,970	...	....
Pensacola, Fla.	...	....	18	....	39	250,000	..	....
Pittsburg, Pa.	25.94	964,505	...	....	11	140,071	..	......
Pittsfield, Mass.	..	......	..	....	1	....	.5	....
Poughkeepsie, N. Y.	.25	6,807	.352	10,587	.227	4,016	.625	9,900
Providence, R. I.	3.67	....	...	....	3.20	119,065	...	....
Pueblo, Colo.	1.6	....	8.75	170,000	2.5	14,880	7	40,000
Racine, Wis.	5.1	191,326	...	....	2.6	34,578	...	....
Richmond, Ind.	1.82	8,000	3	12,000	1.27	6,635	5	60,000
Rockford, Ill.	3.16	25,777	...	....	...	....	...	....
Saginaw, Mich.	3.59	163,647	5	240,000	4.21	65,676	..	......
Salt Lake City, Utah	6.62	441,767	4	320,000	11.25	76,739	40	413,000
San Antonio, Tex.	32	140,000	2.5	65,000	5	15,840	12	50,000
San Diego, Cal.	4.33	210,852	7.05	......	..	......	...	......
Sandusky, O.	.4	16,000	2	150,000	2	20,000	4	100,000
San Jose, Cal.	...	....	...	....	12.26	53,986	8.5	122,500
Savannah, Ga.	1.75	....	1.75	50,000	...	....	...	....
Seattle, Wash.	16	985,129	..	......	24.5	415,573	..	....
Sedalia, Mo.	2.75	53,338	1.75	....	1.5	8,214	...	......
Sheboygan, Wis.	.33	9,430	1.2	34,000	1	7,125	75	5,000
Somerville, Mass.	1.23	28,789	1.75	28,000	1.93	25,766	2	25,000
South Bend, Ind.	4.55	135,562	...	....	1.7	17,459	...	....
Springfield, Ill.	4.43	154,000	5	175,000	1.91	10,880	5	25,000
St. Louis, Mo.	25.06	1,160,765	35	....	.55	9,078	..	....
Stockton, Cal.	1	27,000	6	1,479,000	...	....	...	....
Superior, Wis.	7.5	169,613	...	190,000	7	....	15	50,000
Syracuse, N. Y.	3	154,744	4.19	310,060	4.4	43,679	4.4	43,000
Tacoma, Wash.	12	996,787	...	....	18.62	112,395	...	....
Toledo, O.	8.34	259,047	11.18	582,721	7.79	93,687	3.5	24,000
Vicksburg, Miss.	1.75	108,473	.5	37,280	1.5	6,225	.5	3,220
Washington, D. C.	3.12	125,000	3.12	125,000	17.1	692,366	6	......
Wilkesbarre, Pa.	3.19	78,772	...	....	...	....	...	....
Williamsport, Pa.	.2	5,756	1	20,000	1	10,250	1	5,000
Winona, Minn.	.52	8,902	1	31,495	.	....	...	....

The total amount of material excavated in the Culebra Division of the Panama Canal during February was 1,248,265 cu. yds., an increase of 19,759 cu. yds. over the amount excavated in January. Of this amount 1,176,752 cu. yds. were removed from the Canal prism, and 71,513 cu. yds. from the Camacho and Obispo diversions.

Detailed Cost of Jobs of Laying Asphalt Pavement in a Southern California City.

In our issue of Feb. 5, 1908, we gave the detailed cost of a season's work laying asphalt pavement in an eastern city. In this issue, through the kindness of Mr. Charles Kirby Fox, C. E., we are enabled to give the costs of two asphalt paving jobs in a Southern California city.

The first piece of work was done under a Vrooman act contract, the contract price being $1.89 per square yard. It consisted of the construction of pavement on two blocks of street. The street was 48 ft. wide, had 2½ ft. concrete gutters, a rise of 6 in. to 8 in. and a grade of 1 per cent. It drained well and there were no water holes. The pavement consisted of a 5 in., 1-3-6 concrete base, a 1 in. binder course and a 2 in. asphalt wearing surface.

Grading.—The grading cost $0.1233 per square yard and was done by the following organization:

1 foreman at $5.
1 timekeeper at $3.
1 engineer at $3, part time on steam roller and part time on plowing.
2 laborers and 2 teams at $4 plowing.
6 laborers and teams at $4 hauling away dirt.
14 laborers at $2 shoveling.

Concrete Base.—The 5-in. concrete base was made of a 1-3-6 mixture. On Job No. 2 it was found, however, that these proportions did not work well, as all the voids were not filled and that a 1-3-5 or 1-4-6 mixture made a better concrete. The concrete was hand mixed on two 7 ft. by 7 ft. boards, in the following manner: First, the sand and cement were dumped on the board and hoed across and wet; then the stone was dumped on the mortar and the whole mess pulled back and forth across the boards and on the ground in about the place it was to occupy. In the meantime the other board was being filled up and the operation repeated, the first board being pulled a little forward and refilled. The concrete secured was fair. The cost of mixing and placing the concrete was as follows:

	Per cu. yd.	Per sq. yd.
.93 bbl. cement at $2.50....	$2.28	$0.316
.45 cu. yd. sand at .80.......	.31	.043
.9 cu. yd stone at $2.00.......	1.80	.250
Tools and water..........	.12	.016
Labor and supt..........	1.20	.166
Total	$5.71	$0.791

The wages and organization of the gang engaged in mixing and placing the concrete base were as follows:

1 superintendent at $5.
1 timekeeper at $3.
2 laborers at $2 wheeling sand.
3 laborers at $2 wheeling stone.
6 laborers at $2 mixing.
1 laborer at $2 tending water.
2 laborers at $2 leveling and spreading.

TABLE SHOWING PREVAILING WAGES FOR LABOR AND PRICES OF PAVING MATERIALS IN 96 CITIES.

	Working Day Hours.	Common Labor.	Paver.	Team with Driver.	Cement Per bbl.	Broken Stone Per Cu. yd.	Sand Per Cu yd.	Paving Brick Per M.	Asphalt Per ton.
Albany, N. Y.	8	$1.75	$4.50	$5.00	$1.45[1]	$1.50	$0.25[2]	$23.25[3]	..
Allentown, Pa.	10	1.50	....	4.25	1.60	1.08[4]	2.03	....	..
Ann Arbor, Mich.	9	1.75	...	4.00	2.00	..	.75	21.00	..
Atchison, Kan.	8	1.50	1.76	3.00	2.30	1.50	.85	11.00	..
Battle Creek, Mich.	10	2.00	3.50	4.00	.70	..	.10	20.75	..
Bay City, Mich.	10	1.75	4.00	3.50	1.60	1.25	.90	17.00	28.50
Beaumont, Tex.	9	1.75	4.00	4.50	1.95	1.50	.87	21.00	..
Binghamton, N. Y.	8	1.75	3.50	3.50	1.60	1.00[5]	1.00	24.00[6]	
Bridgeport, Conn.	8	1.75	4.00	5.00	1.80[7]	1.50[7]	1.25[7]	27.00[7]	
Brockton, Mass.	8	2.25	...	4.50	..	1.00[8]	...	....	..
Buffalo, N. Y.	8	1.75	3.20	5.00			..	..	..
Butte, Mont.	8	3.50	6.00	7.00	3.45	1.15	1.00	.	..
Cedar Rapids, Ia.	10	1.75	4.00	3.50	2.00	1.35	1.00	20.00	..
Charlotte, N. C.	10	1.00	....		.85	1.10	.70	...	...
Cheyenne, Wyo.	8	2.50	...	5.00	3.00	.	.50	..	..
Clinton, Ia.	10	2.00	3.00	3.50	1.80	1.50	.60	14.50	..
Columbus, O.	10	1.85	3.50	4.25	1.60	1.25	1.25	15.00	...
Council Bluffs, Ia.	10	1.75	2.50	3.50[9]	2.00	2.25	.70	23.00	..
Dayton, O.	10	1.75	2.25	4.50	1.50	.	.75	17.00	...
Denison, Tex.	10	1.50	.	....	..	..	..	....	....
Detroit, Mich.	8	1.75	2.50	4.50	1.46[10]	.84[11]	.50	19.75[12]	26.70
East Liverpool, O.	9	1.75	3.50	4.50[13]	..	.	.65	8.00	...
East St. Louis, Ill.	8	1.75	2.50	3.50	1.70	1.10	1.00	16.18	..
Easton, Pa.	.	.20[15]	..	.50[15]	..	.90[16]	.	....	..
East Orange, N. J.	10	1.55	3.50	5.00	1.60	2.14	1.00	..	
Elgin, Ill.	9	2.00	[17]4.00	4.50	1.60	1.35	1.50	20.00	.
Elizabeth, N. J.	10[18]	1.75	5.00	4.00	1.50[19]	.90	.70	..	....
Elmira, N. Y.	8	1.75	5.00	3.50	1.70	1.00	1.25	22.50	35.00
Evanston, Ill.	9	2.00	4.50	5.40	2.15	1.25	1.25	19.00	.....
Fond du Lac, Wis.	.	2.25	2.75	4.00	1.80	.91[20]	1.00[20]	26.00	...
Fort Wayne, Ind.	10	1.75	2.50	4.00	1.40	1.05	.70	19.00	25.00
Fort Worth, Tex.	9	1.75	2.00	3.50	2.50	1.00[5]	1.50	14.50	.....
Grand Rapids, Mich.	10	2.00	3.00	4.00	2.00	.	.90	22.00	...
Great Falls, Mont.	8	3.00	..	6.00	3.70	2.00	1.25	.	
Harrisburg, Pa.	10	1.50	3.50	...		1.00		.	
Haverhill, Mass.	8	2.00	2.25	4.50		.		...	.
Holyoke, Mass.	8	2.00	2.25	4.50	1.85	1.26	.10	26.50	.
Jamestown, N. Y.	8	1.75	2.50	4.00	1.60	1.50	1.75	14.00	15.00
Kansas City, Kan.	8	1.75	..	4.00	2.00	1.66	1.00	11.00	.
Keokuk, Ia.	10	1.75	..	3.50	.	1.25[21]	1.00	....	.
Knoxville, Tenn.	10	1.50	3.00	5.50	.95[22]	.75	.75	22.00	.
La Crosse, Wis.	10	2.00	...	4.00		..	.50	..	...
Lansing, Mich.	10	1.75[23]	...	4.00	1.80			.	.
Lawrence, Mass.	8	2.00	3.00	5.00	2.00	1.93	.77	..	
Marion, Ind.	10	1.50	2.50	4.50	1.85	1.15[7]	.60[7]	19.00	...
Medford, Mass.	8	2.00	..		...	..	.	20.00	....
Middletown, N. Y.	8	2.00	3.00	4.50	1.50	1.00	.90	27.00	...
Minneapolis, Minn.	8	2.00	3.25	4.00	1.80	1.75	.80	23.00	..
Milwaukee, Wis.	10	....	..	4.00[14]	1.75[24]	1.20		...	.
Moline, Ill.	10	2.00	3.00	4.00		1.00	.60	.	.
Muncie, Ind.	10	1.50	...	3.25	1.70	1.00[7]	1.00[7]	18.00[12]	.
Nashville, Tenn.	9	1.25	.		2.50	.75	1.50	21.00[20]	...
New Albany, Ind.	10	1.75	2.00	3.50	..	.	..	.....	...
New Bedford, Mass.	8	2.00	2.50	4.50	1.60	1.25	1.00	....	
New Brunswick, N. J.	10	1.65	2.50	5.00	1.65	1.25[7]	1.25[7]	27.50[12]	..
New Castle, Pa.	9	1.75	3.50	4.50	1.58		1.50	11.25	.
Newton, Mass.	8	1.75	...	5.25	1.75	1.33	.	..	.
Niagara Falls, N. Y.	8	1.75	4.00	5.20	1.35	1.35	1.10	14.00	.
North Adams, Mass.	8	1.75	3.50	4.00	1.49	1.00	1.00	30.88	
Oshkosh, Wis.	10	2.00	3.00	4.50	.	1.20	1.25	..	..
Pittsburg, Pa.	..	1.75	...	5.50	1.65			..	
Pittsfield, Mass.	8		....	4.50	1.65	1.62[28]	.75	..	.
Portland, Me.	9	1.75	3.50	5.00	1.84	1.24[25]	.80	25.00	...
Poughkeepsie, N. Y.	8	1.75	4.00	5.00	1.64	1.34	.90	15.00	
Providence, R. I.	9	1.53	2.52	4.05	1.63	1.66	.10		..
Pueblo, Colo.	8	2.00	3.00	4.00	2.15	.20	.50	15.00	....
Racine, Wis.	10	2.00	3.00	5.00	2.20	1.35	.75	18.50	.
Richmond, Ind.	10	1.75	2.50	3.50	2.00	1.00	.75		
Rockford, Ill.	8	1.75		3.75	...	.	..	.	..
Saginaw, Mich.	9	2.00	...	4.50	1.53	1.40	.90	17.00	.
Salt Lake City, Utah	8	2.25		4.50	2.65	1.00	.90		22.00
San Antonio, Tex.	8	1.50	5.00	3.00	16.00[25]	1.35	1.40	19.00	....
San Diego, Cal.	8	2.00	7.50	5.00	3.00	2.50	1.25	.	
Sandusky, O.	10	2.00	2.50	4.00	1.80	1.25	.50	19.50	.
San Jose, Cal.	8	2.50	..	5.00	2.25[26]	1.70	1.00		..
Savannah, Ga.	9	1.50	[27]2.50	3.50	2.00		.	23.00	..
Seattle, Wash.	8	2.25	5.00	6-7	2.80	.	1.00	22.00	20.00
Sedalia, Mo.	10	1.50	3.50	4.00	.65[22]	1.25	1.30	12.50	.....
Sheboygan, Mich.	10	1.75	2.50	4.50	2.65	1.20	.75	27.00	.....
Somerville, Mass.	8	2.00	...	3.50[29]	1.42	1.09[30]	.65[20]	12.50	.
South Bend, Ind.	10	2.00		4.50	1.65	1.40	.90	21.00	30.00
Springfield, Ill.	9	1.75	2.00	3.50	1.50	1.30	1.00	11.00	27.00
Superior, Wis.	10	2.00	3.50	5.00	2.00	1.70	1.00	26.00	..
St. Louis, Mo.	8	1.75	4.00	4.00	1.35	1.00	1.00	15.00	25.00
Stockton, Cal.	8	2.50	.	5.00	2.00	2.00	.50	.	.
Syracuse, N. Y.	8	1.75	3.50	4.00	1.60	1.20	1.00	14.00	35.00
Tacoma, Wash.	8	2.00	6.00	6.00	3.00	.75	.75	21.00	18.00
Toledo, O.	8[31]	1.75	3.00	4.00	1.45	1.00	.95	20.00	30.00
Troy, N. Y.	8	1.50	4.00	5.00		1.25	.50	24.00	.....
Vicksburg, Miss.	10	1.50	2.50	4.00	2.60	2.20[5]	1.50	22.00	
Walla Walla, Wash.	8	2.50	...	4.50	3.50	2.00	2.00	.	
Washington, D. C.	8	1.50	3.50	4.00	1.80	1.50	.74	22.00	
Wilkesbarre, Pa.	10	1.50	3.50	4.00	1.40	.75	1.00	25.20[32]	
Williamsport, Pa.	9	1.75	3.00	5.00	1.50	1.15	.65	20.00	
Winona, Minn.	10	1.75	2.00	4.00		1.25	.	.	

[1] Net. [2] At Bank. [3] F. o. b. Albany. [4] Gravel and sand for concrete cost about $.75 per cu. yd. [5] Gravel. [6] Block. [7] Material delivered on the work. [8] Per ton from city crushers; $1.45 purchased. [9] to $4. [10] Natural cement $.61. [11] 2 in. per ton. [12] F. o. b. City. [13] To $5. [14] To $3.50. [15] Per hour. [16] Per 2,000 lbs. on street. [17] Asphalt paver $3. [18] Eight hours for pavers. [19] To $1.75. [20] F. o. b. cars. [21] At crusher. [22] Natural cement. [23] To $2.50. [24] To $2.00. [25] Per ton. [26] For Californian, $3.75 for imported. [27] To $3. [28] Delivered on dock costs $.60. [29] Average, teams owned by city. [30] Per ton on car. [31] 8 to 10. [32] Some of brick cost $19.00.

1 laborer at $2 tamping

The tools used were as follows:

Two 7 ft. by 7 ft. mixing boards, 7 wheelbarrows, 12 picks, 12 shovels, 6 hoes, 300 ft. of hose, 1 tamper, 12 lanterns and 1 tool box.

Binder. The 1 in. binder course cost as follows:

	Per sq.yd.
Asphalt at $20 per ton	$0.063
Binder stone at $2 per cu. yd.	.081
Labor and plant	.045
Total	$0.180

The 2-in. asphalt wearing surface was mixed in a plant having a capacity of 8 cu. ft. The tools used in connection with the wearing surface work consisted of a 2½ ton, 30-in. roller, a 300-lb. hand roller, a fire pot, 2 Watson wagons, 2 smoothers, 6 tampers, 6 shovels, 2 dirt picks, 6 asphalt picks, 3 rakes, 5 brooms and 4 wheelbarrows.

The cost of the 2-in. asphalt wearing surface was as follows:

	Per sq. yd.
Asphalt at $20 per ton	$0.198
Sand at $1 per cu. yd.	.045
Dust at $10 per ton	.090
Labor	.090
Plant	.198
Total	$0.621

The wages and organization of the gang engaged in the wearing surface work were as follows:

Superintendent at $5.
Timekeeper at $3.

Plant forces:

1 engineer at $3.50.
1 mixer at $3.
1 mixer helper at $2.50.
1 mixer dipper at $2.50.
2 men at $2 shoveling to heater.
3 men at $2 wheeling.
2 teams at $4 hauling to streets.
2 rakers at $3.
3 shovelers at $2.50.
1 smoother at $2.00.
1 tamper at $2.10.
2 roller men at $2.50.
1 engineer roller at $3.50.
1 man at $2 sweeping.

The second piece of work was done in the fall of 1907 by private contract, at a contract price of $1.89 per square yard. The work consisted of the construction of pavement on five blocks of streets and four alleys. The streets were 48 ft. wide, had a rise of 6 in., and a grade of 1 per cent; they had no gutters. The alleys were 20 ft. wide and had a grade of .4 per cent to 1 per cent. The alley that had a 1 per cent grade drained well, but those where grade was less had to be ironed out. The alleys had no gutters. Experience in the city where this pavement was laid has shown that if the gutters fall more than ⅛ in. to the foot they can be made to drain by using the straight edge. If the fall is less than ⅛ in., there will be water holes

TABLE SHOWING AMOUNT AND AVERAGE PRICE OF BRICK PAVEMENT LAID IN 1907 IN 65 CITIES.

	Sq. Yds.	Av. Price per Sq. Yd., Including Base.	Guarantee, Years.	Price per Cu. Yd. for Grading if Paid Separately.	Total Thickness Pavement, Inches.	Concrete Base Thickness, Inches.	Concrete Base Portland or Natural Cement.	Concrete Base Proportions.
Albany, N. Y.	25,383	$2.28[1]	5	.....	11¾[2]	6	P	1-3-6
Ann Arbor, Mich.	409	1.60*	..	$0.25	10	6	P	1-8
Atchison, Kan.	19,891	1.28*	1	.35	9½	.	..	.....
Battle Creek, Mich.	18,712	1.565	24	.....	11	6	N	1-6
Bay City, Mich.	6,456	1.78	1	.....	9	5	P	1-3-5
Bayonne, N. J.	4,800	....	5	.40	9	5	P	1-3-6
Beaumont, Tex.	9,932	2.06[3]	..	.....	12	6	P	1-3-6
Binghamton, N. Y.	38,195	1.99	10	.....	11	6	P	1-2-5
Bridgeport, Conn.	7,447[4]	2.86	5	.....	12	6	P	1-4-8
Buffalo, N. Y.	34,932	2.67	10	....	11	6	P	1-10
Cedar Rapids, Ia.	25,308[5]	1.48*	..	.30	12		.	.....
Cleveland, O.	406,284	1.35*[6]	3	.40	5	.	.	....
Clinton, Ia.	1,405[6]	1.74*	1	.45	10	4	P	1-3½-6
Columbus, O.	112,740	1.57*	5	.50	11	6	P	1-4-8
Council Bluffs, Ia.	36,945	1.975	1	....	9½[7]	4[8]	P	1-3-5
Dayton, O.	78,000	1.68	5	....	11	6	P	1-3-7
Denison, Tex.	4,473	2.09	..	.55	9½	4	P	1-9
Detroit, Mich.	63,476	2.50	..	.....	...	.	..	.....
East Liverpool, O.	9,763[9]	1.16 2-3*	1	.33 1-3	...	.	..	.....
East St. Louis, Ill.	82,807	1.60*	1	.25[10]	11½	6	P	1-3-6
Elgin, Ill.	11,112	2.10	5	.....	6	5	P	1-3-6
Elmira, N. Y.	1,686	2.586	5	.....	4	11	P	1-3-6
Evanston, Ill.	12,611	1.73*[25]	5	.25[26]	11¼	5	P	1-3-7
Fond du Lac, Wis.	18,000[11]	2.35*	5	.50	10½	6	P	1-3-6
Fort Wayne, Ind.	1,925	1.62*	10	.45	11	6	P	.....
Fort Worth, Tex.	10,000	2.00	..	.50	11	5	P	1-9
Grand Rapids, Mich.	73,685	1.85*	5	.25	11	6	P	1-4-8[12]
Harrisburg, Pa.	709	2.00	5	.....	9	6	P	1-3
Holyoke, Mass.	11,539	2.26	..	.....	10	5	P	1-3-6
Jamestown, N. Y.	10,477	1.64*	5	.40	11	6	P	1-9
Kansas City, Kan.	2,500	1.11	5	.....	...	.	..	.....
Knoxville, Tenn.	7,065	2.17	8	.....	12	6	N	1-2-4
La Crosse, Wis.	3,378	1.865	..	.....	12	6	N	1-1½-4
Lansing, Mich.	32,859	1.56[13]	5	.....	...	.	..	.....
Middletown, N. Y.	5,000	2.50	..	.....	12	6	P	1-3-5
Milwaukee, Wis.	51,349	2.15	..	.....	...	.	..	.....
Minneapolis, Minn.	23,760	2.10	..	.....	10	5	P	1-3-6
Moline, Ill.	13,340	1.80	5	.....	10½	5	P	1-3-6
New Albany, Ind.	21,255	1.85	5	.....	...	5	N	1-2-5
NewBrunswick, N.J.	19,000	2.41	5	.....	11½	6	P	1-3-6
New Castle, Pa.	.....	1.38*	5	.36	11½	6	P	1-3-8
Niagara Falls, N. Y.	13,218	2.20	10	.....	8½	4	P	1-5-8
Oshkosh, Wis.	21,100	2.00	5	.....	11½	6	P	1-3-7
Pittsburg, Pa.	30,936	1.87*	1	.53	11	6	P	1-3-6
Portland, Me.	250	3.35	..	.....	...	6	P	1-3-6
Poughkeepsie, N. Y.	3,686[14]	1.847	..	.....	10½	2[15]	P	1-2-4
Racine, Wis.	63,978	2.10*	..	.....	...	5	P	1-3-5
Saginaw, Mich.	28,130	1.67*[26]	..	.40	11	6	P	1-3-5
Sandusky, O.	6,900[15]	2.00*	5	.50	11½	6	P	1-3-6
Savannah, Ga.	12,047[16]	1.63	..	.....	.....	.....	.....	.....
Seattle, Wash.	37,119	2.60*	6	.70	9	5[17]	..	.....
Sedalia, Mo.	27,632	1.52	5	.....	10	4	.	.....
Sheboygan, Mich.	2,000	2.00	..	.....	..	6	P	1-3-5
South Bend, Ind.	86,859	1.34½*	..	.39	11	.	..	.....
Springfield, Ill.	59,115	1.67	..	.....	11	6	P	1-3-5
Superior, Wis.	3,112	2.39*	..	.60	9	5	P	1-2½-5
St. Louis, Mo.	196,210	1.80*	5	.....	12	6	P	1-4-7
Syracuse, N. Y.	35,461	1.98*	10	355	11	6	P	1-3-6
Tacoma, Wash.	1,793[20]	3.10*	..	.....	9[18]	4[19]	P	1-3-6
Toledo, O.	86,775	1.75*[21]	5	.....	...	6	.	.....
Troy, N. Y.	207,749	2.20	5	.....	10	6	P	1-3½-7
Vicksburg, Miss.	36,503	2.25*	10	.625	11½	6	P	1-3-6
Washington, D. C.	13,758[27]	2.50	..	.....	..	.	.	.....
Wilkesbarre, Pa.	11,315[22]	2.04	..	.23	12	6	P	1-2-5
Williamsport, Pa.	2,640	2.00	1	.....	11½	6	P	1-3-7

*Does not include grading.

[1] On concrete base, for gravel base $1.88, and for telford base $2.19. [2] For concrete base; for gravel base total thickness is 13¾; for telford base thickness is 15¾. [3] Done by city forces. [4] Reese Hammond blocks. [5] Small amount of this pavement was laid on 5 in. concrete base at $1.89 and $1.98 per square yard; greater part was laid on 6 in. of macadam and 2 in. of sand. [6] From $1.35 to $1.53. [6] In 20 ft. alley. [7] Some 10½ in. and 11½ in. thick. [8] Some of the base is 4 in., 5 in. and 6 in. thick. [9] Laid on 8 in. gravel and 2 in. of sand. [10] $.25 for excavation, $.70 for fill when hauled in. [11] Capitol and Metropolitan brick used. [12] Proportion used natural cement 1-2-4. [13] Work complete on gravel base. [14] Day work repaving. Syracuse blocks used. [15] New base 2 in.; old base 5 in. [16] Metropolitan block used. [16] Laid on soil. [17] 5 in. to 6 in. base. [18] 9 in. and 11 in. thick. [19] 4 in. and 6 in. base. [20] Miles. [21] $1.40 per sq. yd. on 6 in. broken stone base. [22] 28,098 sq. yds. of pavement was laid on 6 in. crushed stone base at average cost of $1.70 per sq yd. and 4,952 sq. yds. was laid on a similar base at a cost of $1.60 per sq. yd. [23] Where excavation exceeds 12 in. it is paid for at rate of $.20 per cu. yd. [24] City does own work. [25] $1.75 to $2.05. [26] $0.10 to $0.25. [26] $1.67 with asphalt filler, $1.40 with cement filler. [27] Alley pavement vitrified block, 3 in. x 4 in. x 4 in., 44 per yd.

TABLE SHOWING AMOUNT AND AVERAGE PRICE OF WOOD BLOCK PAVEMENT LAID IN 1907 IN 12 CITIES.

	Sq. Yds.	Av. Price per Sq. Yd., Including Base.	Guarantee, Years.	Price per Cu. Yd. for Grading if Paid Separately.	Total Thickness of Pavement, Inches.	Concrete Base Thickness, Inches.	Concrete Base Portland or Natural Cement.	Concrete Base Proportions.
Bayonne, N. J.	2,300	.....	10	.40	8½	5	P	1-3-6
Bridgeport, Conn.	13,696[1]	$3.035	5	.....	10[2]	6	P	1-4-6
Detroit, Mich.	178,835[3]	2.19	..	.....	..	.	..	.....
Grand Rapids, Mich.	4,990[4]	2.50*	5	.....	10	6	N	1-2-4
Great Falls, Mont.	15,900[4]	4.09*	7	....	10[5]	5½	P	1-4-7
Holyoke, Mass.	1,383	3.31	..	....	8	4½	P	1-3-6
La Crosse, Wis.	9,221	2.607	..	...	10	6	N	1-1½-4
Milwaukee, Wis.	7,749[4]	3.25	..	....	..	.	.	.....
Minneapolis, Minn.	102,000	2.80	..	....	10	5	P	1-3-6
Niagara Falls, N. Y.	1,320	2.50[6]	10	...	7½	4	P	1-4[7]
Oshkosh, Wis.	3,330[4]	3.04	5	...	11	6	P	1-3-7
Superior, Wis.	7,516	2.89*	5	.70	3	5	P	1-3-7

*Does not include grading.

[1] Wyckoff blocks. [2] 3 in. blocks, 1 in. sand cushion and 6 in. base. [3] Cedar blocks; also 8,104 sq. yds. of creosoted block at $3.08 per sq. yd. [4] Creosoted. [5] Street was paved in 1895 with 6 in. round cedar blocks on concrete base with 10 in. gutters; in 1907 was repaved with 3½ in. creosoted blocks, and the gutters reduced to 7 in., this change in construction necessitating a filler course of 5½ ins. on top of original base—1-4-7 concrete was used for sand filler course. [6] Does not include foundation or curbing. [7] 1-4 base and 1-2 finish.

Where the gutter has to be raked it was found advisable to have double the fall per foot. The pavement consisted of 4 in., 1-3-6 concrete base, a 1 in. binder course and a 2 in. wearing surface.

The grading was done by another contractor and cost $0.099 per square yard, the work being done by the following force:

1 foreman at $3.

½ timekeeper at $3.

1 engineer at $3 part time on steam roller and part time plowing.

2 laborers and 2 teams at $4 plowing.

8 teams at $4 hauling dirt away.

18 laborers at $2 shoveling.

The concrete base was laid by the contractor who did the grading. The concrete was mixed in a Ransome mixer, a 3 cu. ft. barrow of sand being dumped into the mixer first, then 1 cu. ft. of loose cement and finally two barrows of stone. After several turns of the mixer the mass was discharged and taken in scoops by the laborers and put in place. Two laborers spread the mixture, two laborers leveled it, and two more laborers tamped it. The mixture was as wet as it could be without the mortar running from the stone. Each wheelbarrow man had two helpers. The gang usually consisted of 28 men; 42 men were the most that could be used to advantage. The concrete on this job was better than that on the first job. The cost of mixing placing the 4 in. concrete base was as follows:

	Per cu. yd.	Per sq. yd.
95 bbl. cement at $3.00	$2.85	$3.16
45 cu. yd. sand at $0.80	.31	.034
91 cu. yd. stone at $2.00	1.82	.202
Labor and Supt.	.974	.108
Rent of machine, repairs, oil.	.246	.027
Total	$6.20	$0.687

The stone used in the concrete was hauled from cars about ½ mile distant, the cost of unloading and hauling being as follows:

	Per cu. yd.
Foreman at $3	$0.03
Laborers at $2	.15
Teams at $4	.19
Total	$0.37

This cost is included in the $2 in the table.

The wages and organization of the force engaged in mixing and placing the concrete base were as follows:

1 fireman at $100 per month.

1 engineer or mixer at $3.50.

1 handyman at $2.50.

1 team at $4.

1 laborer at $2 tending mixer discharge.

2 laborers at $2 carry and measure cement.

1 laborer at $2 wheeling sand, and 1 laborer or more at $4 helping.

2 laborers at $2 wheeling stone and 2 or more laborers at $2 helping.

2 laborers at $2 dumping concrete.

2 laborers at $2 tamping.

9 laborers at $2 taking concrete from machine.

TABLE SHOWING AMOUNT AND AVERAGE PRICE OF MACADAM LAID IN 1907 IN 37 CITIES.

	Sq. Yds.	Average Price Per Sq. yd	Guarantee Years	Price Per cu. yd. for Grading if Paid Separately	Total Thickness of Pavement Inches.
Albany, N. Y.	1,661	$1.30	2	....	8
Bayonne, N. J.	5,600	....		$0.40	9
Brockton, Mass.	39,123	.60		...	5-6
Easton, Pa.	22,104	.435	.	...	6-10
East Orange, N. J.	38,150[1]	1.00*	1	.35	12
Elizabeth, N. J.	4,410[1]	1.25	1	. .	15
Evanston, Ill.	56,226	1.05*[11]	5	.25[12]	12
Fond du Lac, Wis.	6,000	.70*	1	.50	12
Holyoke, Mass.	27,124	.53		...	
Jersey City, N. J.	8,046	1.00	5	.40	12
Keokuk, Ia.	10,172	.635*	1	.35	10
La Crosse, Wis.	33,529	1.08		...	12
Medford, Mass.	29,000[2]	1.50		..	
Milwaukee, Wis.	87,215	.80	.	...	..
Minneapolis, Minn.	20,592	.90		...	8-12
Nashville, Tenn.	9,693	1.65[3]	.	....	15
New Bedford, Mass.	29,793	.53		....	12
Newton, Mass.	65,000[4]	.40		....	4
Oshkosh, Wis.	14,026	.65	.	....	10
Portland, Me.	22,275	.82	.	....	6
Providence	33,407	...	.	...	8[5]
Racine, Wis.	7,845	1.24*	.	....	..
Richmond, Ind.	33,000	.50		....	7
Rockford, Ill.	65,005[6]	.39		....	8
Salt Lake City, Utah	64,000	1.00*[7]		.77[8]	9
San Antonio, Tex.	280,000[4]	.50		....	8
Savannah, Ga.	6,397[9]	.50		....	..
Sedalia, Mo.	12,555	.90	5	....	12
Sheboygan, Wis.	4,568	.99	.	....	12[13]
Somerville, Mass.	5,800[4]	.65	.	....	..
South Bend, Ind.	1,006	.65*	.	.17	6
Superior, Wis.	50,506	1.25*	.	.80	12
Stockton, Cal.	83,000	.52*	.	.50	7
Toledo, O.	10,977	1.40*[10]	.	....	..
Troy, N. Y.	800	1.90	.	....	..
Washington, D. C.	47,300	80½[14]	.[15]	....	..
Winona, Minn.	8,902	1.00	.	....	12

*Does not include grading.

[1]Telford macadam. [2]About one-half of this was over a marshy soil and 4 ft. average fill, thus making the average price higher than usual; the ordinary cost for 6 in. macadam including excavation and grading is about $1 per yd. [3]Miles of 30 ft. roadway; of this amount 7.43 miles was done by city at $1.65 per lin. ft. and 2.23 miles by contract at $1.79 per lin. ft. [4]By day labor. [5]Loose. [6]Done by City Engineer's department. [7]$.65 to $1.00. [8]$.50 to $.77. [9]Gravel laid on soil. [10]Per lin. ft. [11] $0.92 to $1.05. [12] $0.10 to $0.25. [13] 9 in. limestone, 3 in. granite. [14] $0.60 to $0.80. [15] By day labor.

TABLE SHOWING AMOUNT AND AVERAGE PRICE OF STONE BLOCK PAVEMENT LAID IN 1907 IN 22 CITIES.

	Sq. Yds.	Av. Price per Sq. Yd., Including Base.	Guarantee, Years.	Price per Cu. Yd. for Grading if Paid Separately.	Total Thickness of Pavement, Inches.	Concrete Base Thickness, Inches.	Concrete Base Portland or Natural Cement.	Concrete Base Proportions.
Albany, N. Y.	874	$2.77	2	.....	22½[1]	1	1	1
Buffalo, N. Y.	8,347	3.63	10	.. ..	15	6	P	1-10
Butte, Mont.	4,520	6.56	..	....	13[2]	4[3]	P	1-3-6
Cheyenne, Wyo.	550	3.83	..	.....	11	5	P	1-2-5
Cleveland, O.	18,366	3.15*	5	.40	6	.	.	.....
Columbus, O.	13,500	3.25*	5	.50	14	6	P	1-4-8
Elizabeth, N. J.	46,458	2.05	1	.....	12[4]	.	..	.....
Haverhill, Mass.	1,612	1.80[5]	..	.35	16	.	..	.....
Jersey City, N. J.	24,483[6]	1.60	..	.40	6	.	..	.....
Lawrence, Mass.	13,076[7]	....	..	....	12[8]	4[9]	P	1-3-5
Milwaukee, Wis.	7,484[10]	3.10	..	.....	..	.	..	.....
Minneapolis, Minn.	30,254	2.80[11]	.	...	8[13]	5	P	1-3-6
New Bedford, Mass.	1,087	3.00	..	....	16	5	P	1-3-5
Niagara Falls, N. Y.	2,654	3.37	10	...	12	4	P	1-4
Pittsburg, Pa.	125,307[12]	2.17*	1	.53	15	.[14]	..[14]	..[14]
Portland, Me.	8,445	2.04	..	.....	..	.	..	....
Providence, R. I.	10,199[15]	....	..	.. .	15[16]	6[16]	P	1-3-6
Seattle, Wash.	34,147	3.90*	..	.70	10½	.	.	.....
Superior, Wis.	15,441	2.93*	5	.75	11	5	P	1-2½-5
St. Louis, Mo.	58,330[17]	2.70*	7	.....	12	6	P	1-4-7
Syracuse, N. Y.	718	3.55	10	....	14[18]	6	P	1-4-7
Tacoma, Wash.	2,565[19]	4.00*	..	.....	11½[20]	4½[21]	P	1-3-6

*Does not include grading.

[1]Granite on a sand base 14 in. thick. [2]13 to 15 in. [3]4 in. to 6 in. [4]Stone and sand [5]Sand base. [6]In addition there was 21,694 sq. yds. of stone block repaving done at an average price of $1.50 per sq. yd. [7]Work done by street department. [8]12 to 13 ins. [9]4 to 5 ins. [10]Granite paving; in addition there were 9,625 sq. yds. of limestone block repaving done at an average price of $.50 per sq. yd. [11]Some of the pavement laid on sand and some on concrete, price ranging from $2.10 to $2.80 per sq. yd. [12]8 ins. to 13 ins. [13]"Ligonier" block. [14]Class "D" gravel base, 9 ins. thick. [15]2,727 sq. yds. with base, 7,472 sq. yds. without base. [16]For pavement with base. [17] Granite. [18]Including 2 in. sand cushion. [19]Miles. [20]11½ in. and 13½ in. [21]4½ in. and 6 in.

TABLE SHOWING AMOUNT AND AVERAGE PRICE OF BITULITHIC PAVEMENT LAID IN 1907 IN 13 CITIES.

	Sq Yds.	Av. Price per Sq. Yd., Including Base.	Guarantee, Years.	Price per Cu. Yd. for Grading if Paid Separately.	Total Thickness Pavement, Inches.	Concrete Base Thickness, Inches.	Concrete Base Portland or Natural Cement.	Concrete Base Proportions.
Ann Arbor, Mich.	7,109	$2.03*	10	$0.25	8½	6	P	1-8
Charlotte, N. C.	40,000	2.15	5	...	6		..	....
Fort Worth, Tex.	5,000	2.35	10	.45	6½		.	.....
Knoxville, Tenn.	17,450	2.27	8		8	6	N	1-2-4
New Bedford, Mass	12,802	2.40	5		6			
Niagara Falls, N. Y.	21,241	2.40	10		6	4	P	1-5-8
Portland, Me.	12,507	3.19	5		8	6	P	1-3-8
Providence, R. I.	21,189	2.25	5		6			..
Pueblo, Colo.	9,040	2.58	5		8½	.	.	.
St. Louis, Mo.	101,767	2.15*	5		8	6	P	1-4-7
Syracuse, N. Y.	3,767	2.43*	10	.45	6[3]			.
Toledo, O.	11,936	2.38*	5	.	8[4]			...
Troy, N. Y.	5,353	3.25	5	.	9	6	P	1-3½-7

*Does not include grading.

[1] By city forces. [2] On 6-in. macadam base. [3] 2 ins. of bitulithic on 6-in. of broken stone rolled to 4 in. [4] 2 in. of bitulithic on 6 in. of broken stone.

The plant used consisted of a Ransome concrete mixer with 6 h. p. gasoline engine mounted on wheels, one 1 cu. ft. cement box, four 3 cu. ft. wheelbarrows, 29 scoops, 12 short-handled shovels, 18 long-handled shovels, 12 picks, 400 ft. of hose, three tampers, 12 lanterns and one tool box.

The stone used in the binder had the dust screened out and was passed through a 1¼ in. screen. It was found, however, that this did not leave enough fine stuff, pea size or thereabouts, so screenings from the sand were taken and from this was screened out all particles above 1 in. in size. One part of these screenings was mixed with two parts of broken stone and heated to 200° F. Four cubic feet of this was mixed with 27 lbs. of melted asphalt, making a strong binder. The cost of the binder was $0.171 per square yard.

The wearing surface was mixed in the proportion of 4 cu. ft. of sand heated to about 300° F., 30 lbs. of cold dust, and 50 lbs. of melted asphalt. These were mixed very thoroughly usually taking 1¼ minutes to the batch. The mixture usually arrived on the street at about 280° F. It was found that a 4 cu. ft. batch would lay about 20 sq. ft. of 2 in. surface. The cost of the wearing surface was $0.549 per square yard.

The wages and organization of the force engaged in preparing and laying the binder and the wearing surface were as follows:

Superintendent at $120 per month.

Plant crew:

1 engineer at $3.50.
1 mixer at $3.00.
1 mixer helper at $2.50.
1 heater at $2.50.
1 man shoveling sand and 1 man shoveling marble dust at $2.50.
1 scraper team at $4.00.
2 teams hauling to street at $4.50.
1 engineer on roller at $3.50.
2 rakers at $3.00.
2 shovelers at $2.50.
2 hand roller men at $2.50.
2 tampers at $2.50.

The plant used consisted of a 4 cu. ft. mixer, a 5 ton, 38 in. roller, a 500 lb. hand roller, a fire pot, 3 Watson wagons and teams, a scraper, 3 rakes, 3 shovels, 2 tampers, 3 smoothers, 1 asphalt pick and 2 brooms.

A summary of the costs of the two jobs is given below:

	Job 1. Per sq. yd.	Job 2. Per sq. yd.
Grading	$0.123	$0.090
Concrete	.791	.687
Binder	.180	.171
Surface	.621	.549
Office, collection and general expense estimated	.180.	.180
Total	$1.904	$1.680

Job 2 had more material and better workmanship per unit than Job 1. It was better managed, especially in the asphalt department. Job 1 had an asphalt mixer requiring two cars to move, while on Job 2 the mixer required but one car, but it cost more to move the latter. The small plant was the most economical. On concrete work the lost time of steady pay men when they were not mixing amounted to about 10 cts. per cubic yard; usually, however, when these men were not mixing they were engaged on other work.

TABLE SHOWING AMOUNT AND AVERAGE PRICE OF ASPHALT PAVEMENT LAID IN 1907 IN 39 CITIES.

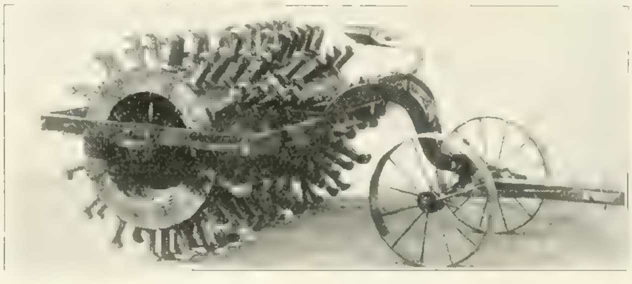
	Sq. Yds.	Av. Price per Sq. Yd., Including Base	Guarantee, Years.	Price per Cu. Yd. for Grading if Paid Separately	Total Thickness Pavement, Inches.	Concrete Base— Thickness, Inches.	Concrete Base— Portland or Natural Cement.	Concrete Base— Proportions.
Albany, N. Y.	31,605	$2.70	10	.....	8½	6	P	1-3-6
Allentown, Pa.	52,312	1.97	1	.....	6½	4	P	1-3-6
Bayonne, N. J.	1,013	.	10	$0.40	7½	5	P	1-3-6
Buffalo, N. Y.	53,748	2.70[1]	10	....	9½	6	P	1-10
Buffalo, N. Y.	78,017	1.96	..	.....	..	.	..	.....
Cleveland, O.	21,078	2.25*	10	.40	9	6	P	1-3-6
Columbus, O.	71,700	2.00*	10	.50	9	6	P	1-4-8
Dayton, O.	34,000	2.10	5	....	9	6	P	1-3-7
Detroit, Mich.	35,392	2.65	10	. .	...	.	.	.....
Elgin, Ill.	10,508	2.10	5	....	7½	5	P	1-3-6
Elizabeth, N. J.	12,150	2.46	10		9½	6	3	1-2-4[4]
Elmira, N. Y.	8,157	2.325	10	. ..	9	6	P	1-3-6
Fond du Lac, Wis.	35,000[5]	2.04*	5	.53	7½	5	P	1-3-6
Fort Wayne, Ind.	61,983	1.90*	10	.45	8½	6	P	1-3-6
Harrisburg, Pa.	148,066	1.70	5	..	9	6	P	1-3
Jersey City N. J.	31,579	1.90	5	.40	6½	5	N	1-3-6
Knoxville, Tenn.	44,900	1.98	8	...	19	6	N[6]	1-2-4
Milwaukee, Wis.	43,939	2.25	5	....	9	6	P	1-3-6
Moline, Ill.	16,793	1.98	10	...	8½	5	P	1-3-6
New Albany, Ind.	56,701[5]	1.745	5	.40	8½	6	N	1-2-5
Niagara Falls, N. Y.	47,804	2.38	10	..	6½	4	P	.....
Oshkosh, Wis.	26,217	2.25	5	....	8½	6	P	1-3-7
Pittsburg, Pa.	135,694	1.69*	5	.53	9	6	P	1-3-6
Providence, R. I.	4,786	1.50[7]	.	....	...	.	..	....
Pueblo, Colo.	38,651	2.[illegible]	5	.33	9	6	P	1-3-6
Racine, Wis.	16,647	2.09*	5	....	...	5	..	1-3-6
Saginaw, Mich.	35,308	1.59*	10	.40	8½	6	P	1-3-5
Salt Lake City, Utah	92,000	2.05[8]*	10	.50[9]	9½	6	P	1-3-7
San Diego, Cal.[15]	9,244	1.66	..	...	8	.	..	.....
Savannah, Ga.	136,717	1.10[2]	5	....	...	.	..	.....
Seattle, Wash.	84,961	2.10*	10	.70	9	5[10]	P	1-4-7
South Bend, Ind.	8,884	2.25*	5	.50	8½	6	P	1-9
Springfield, Ill.	24,315	1.86	5	....	8½	6	P	1-3-5
St. Louis, Mo.	149,945	2.50*	5	....	9	5	P	1-4-7
Stockton, Cal.	13,500	1.71*	..	.25	8	5	P	1-3-6
Syracuse, N. Y.	16,767	1.92*	10	.35	8½	6	P	1-3-6
Tacoma, Wash.	7,672[11]	2.10*	..	...	7½[12]	4[13]	P	1-3-6
Toledo, O.	19,416	1.60[2]	..	.	...	.	..	.....
Troy, N. Y.	11,513[14]	3.37	5	.....	10	.	.	.....
Washington, D. C.	6,767	1.69*[16]	5	.40	9	6	P	1-4-5-5

*Does not include grading.

[1] On new base. [2] Resurface. [3] Both natural and Portland cement used. [4] Also 1-3-6. [5] Trinidad asphalt. [6] Specifications for present year will call for Portland cement concrete, 1-3-6 proportions. [7] Wearing surface. [8] Some at $2.45. [9] Some at $0.77. [10] 5-in and 6-in. [11] Miles. [12] 7½ and 9 ins. [13] 4 and 6 ins. [14] Laid on old granite blocks. [15] 2-in asphalt wearing surface on 6-in. asphalt macadam base. [16] $1.63 to $1.67.

The Improved Petrolithic Roller.

We illustrate herewith the latest model of the Petrolithic rolling tamper, which is designed for compacting the subgrade of roads and streets and for compacting reservoir embankments, as well as for building Petrolithic Pavement. It will be noted that the roller is built in two halves, which facilitates turning it. The iron "feet" or tampers are made somewhat larger than in previous models. It is the tamping action of these iron feet that effects the remarkable consolidation of earth when they pass back and forth over it. If the subgrade of a street is to be compacted, the first step is to plow up the subgrade to a depth of 6 or 8 ins. Then the iron feet of the rolling tamper break up any clods and sink nearly to their full length in the plowed earth, thus starting the compacting of the earth at the *bottom.* As the roller passes back and forth, the iron feet sink less and less into the earth, until finally they ride upon the hard surface that they have produced. There can be no soft spots bridged over by the roller, and the earth is uniformly dense from the bottom to the top. Earth weighing 90 lbs. per cu. ft. in place before rolling, has been plowed up and rolled until its weight became 120 lbs. per cu. ft. Obviously a 6-in. layer of earth of such density makes it unnecessary to use as thick a pavement as would otherwise be needed.



The Improved Petrolithic Roller.

This rolling tamper is made by the Petrolithic Pavement Co., 764 Pacific Electric Bldg., Los Angeles, Cal.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Twelve Additional Letters Commending the American Society of Engineering Contractors.

Additional letters and applications for membership keep coming in to Mr. Gillette, acting chairman of this new organization. The total number of applicants now exceeds 800. Those wishing to make application can find a blank for the purpose on page 24 of the advertising section.

Twelve letters commending the formation of the society follow:

Sir: I notice in current issue of Engineering-Contracting that you have upwards of 700 applications for membership in the proposed Am. Soc. of E. C., which argues good for its formation.

My application was filed several months back, as I firmly believe that a society organized along the lines I understand this is to be, will certainly be a great benefit, not alone to engineers and contractors but to owners whether they be individual or otherwise.

Consider me at your service, if needed, in your new undertaking.

Very truly,
Webber Construction Co.,
F. G. Webber, Pres.
New York City.

Sir:—I take pleasure in sending you my application for membership in the "American Society of Engineering-Contractors."

I believe that such an organization as you propose will be of inestimable benefit to every engineer and contractor in the country, and you may count on my every effort to secure more members.

Trusting that the permanent organization may soon be perfected, I am,

Yours faithfully,
Stuart B. Macafee,
Macafee Concrete Co.,
General Contractors,
Athens, Pa.

Sir:—I wish the movement much success.
Very truly,
W. E. Robertson,
Owner and Chief Eng.
El Paso Bridge and Iron Co.
El Paso, Texas.

Sir:—Please enter my name as charter member of The American Society Engineering-Contractors under terms and conditions of your application blank in Engineering-Contracting.

If you will permit me, I would suggest you place the application blank on some other page than cover pages, as a great many, like myself, do not wish to mutilate their papers.

Very truly yours,
W. C. Reed,
Contractor's Superintendent,
1333 N. Vandeventer, St. Louis, Mo.

Sir:—I am desirous of becoming a charter member of the American Society of Engineering-Contractors, providing the dues and conditions of membership shall prove satisfactory to me when they shall be decided upon.

My occupation is civil engineering, and my present work is that of chief inspector on the Detroit River Tunnel.

Yours truly,
L. G. Palmer,
Chief Inspector,
Detroit, Mich.

Sir:—I am interested in the new society you are forming and am enclosing herewith application for membership.

Yours truly,
W. G. Smith,
Chief Engineer,
Kenefick, Hoffman & Quigley,
Beaumont, Texas.

Sir:—I notice in your publication that it is the intention to form an "American Association of Engineering-Contractors." I wish to state that I am not in the contracting business at present, but at some time I expect to be. I have been City Engineer of Ogden for over eight years; have been engaged in active construction work fifteen years prior to my work with the city.

If it would be permissible under these circumstances, viz., as a prospective contracting engineer, to become a charter member of the proposed organization, I am desirous of having my name enrolled as such, provided the dues and conditions of membership prove satisfactory to me when they shall be decided upon.

Yours very truly,
A. F. Parker,
City Engineer,
Ogden, Utah.

Sir:—We are enclosing you blank filled out for membership in American Society of Engineering-Contractors, provided the dues and conditions of membership shall prove satisfactory when they shall be decided upon. Have given you individual and firm name.

Yours truly,
LeFevre & Edwards,
By J. T. Edwards,
Engineers & Contractors,
Cumberland, Md.

Sir:—I enclose herewith the names of two young engineers employed in our water works contracting department, who are desirous of becoming charter members of the American Society of Engineering-Contractors. We are much interested in this work and trust that the organization will be started in the near future.

Yours very truly,
L. G. Berry,
Contr. Engr.
Des Moines Bridge & Iron Works,
Des Moines, Iowa.

Sir:—The writer will be pleased to render you any service. You have a big field in which to work.

Yours very truly,
Will F. Plummer, Supt.,
Parker Washington Co.,
Contracting Engineers,
St. Louis, Mo.

Sir:—I herewith hand you my application for charter membership to the American Society of Engineering-Contractors, which I understand is to be soon permanently organized.

Yours very truly,
W. T. Turner,
Chief of the Hydrographic Com.,
Lima, Peru.

Sir:—I am desirous of becoming a charter member of "The American Society of Engineering-Contractors," provided the dues and conditions of membership shall prove satisfactory to me when they shall be decided upon.

Yours very truly,
W. D. Waltman,
Supervisor Excavation, I. C. C.,
Empire Canal Zone, Panama.

Work on the various irrigation projects of the U. S. Reclamation Service has reached a point where it is now believed that water will be available in 1908 for the following acreages:

State and Project.	Acres.
Arizona, Salt River	50,000
Idaho, Minidoka	74,000
Idaho, Payette-Boise	55,000
Kansas, Garden City	8,500
Montana, Sun River	16,000
Montana, Huntley	29,000
New Mexico, Carlsbad	20,000
New Mexico, Hondo	10,000
New Mexico, Leasburg	15,000
Nebraska-Wyoming, North Platte	40,000
Nevada, Truckee-Carson	100,000
North Dakota, Williston	5,000
North Dakota, Buford-Trenton	3,500
Oregon, Klamath	20,500
Oregon, Umatilla	7,000
South Dakota, Belle Fourche	12,000
Washington, Sunnyside	44,000
Wyoming, Shoshone	13,000
Total	522,500

Methods and Costs; Some Old; Some New.

Permanent Marks Used in Geodetic Survey.—The permanent marks used in connection with the Geodetic survey of Canada consist of an underground and a surface mark made of 2 ft. title set in and filled with concrete, the point of a 3/16 in. copper bolt set in the concrete marking the exact spot. The top of the underground mark is placed about 4 ft. below the surface and the top of the surface mark about 1½ ft. below the surface so as to be below plowing. Six inches of dry sand intervenes. A reference monument of concrete is placed near each tower erected at the angular points of the quadrilaterals, in a convenient fence corner or out of the way place.

Laying Power Cable Under a River.—In connection with the driving of the two Belmont tunnels under the East River opposite 42nd street, New York City, an air compressor plant was installed on Man O' War's Reef in the middle of the river. The plant was operated by electricity, the method of getting the power cable to it being as follows: A 4 in. pipe was selected, measured out and assembled on 42nd street, special joints allowing for some flexibility being used. Forty-second street at this point runs on an incline for three or four blocks. Accordingly the pipe was placed on rollers, the power cable and a telephone wire inserted inside it, and the ends of the pipe stopped up. A tug boat then hooked onto the pipe and pulled it over to the reef.

Approximate Weight of Building Material.—The following table showing the approximate weight per cubic foot of building materials was compiled by Mr. R. Morrison Snyder, consulting architect, Fort Wayne, Ind.:

Material.	Wt.	Material	Wt.
Metals.		Masonry.	
Bronze	552	Asphalt	130
Copper	550	Blue Stone	160
Iron, cast	450	Brick in Lime	120
Iron, Wrought	480	Brick in Cement	130
Lead	712	Cement, Portland	90
Steel, Structural	490	Concrete	140
Timber.		Gneiss	160
Cedar	23	Granite	165
Chestnut	41	Gravel	120
Cypress	29	Limestone	170
Fir	32	Marble	165
Hemlock	25	Sandstone	145
Oak White	50	Slate	170
Pine, White	24	Terra-Cotta	110
Pine, Yellow	35	Tile	115
Spruce	25		

Moving a 5-Story Brick Building.—A 5-story brick building, 25x75 ft. and weighing 2,300 tons, was moved by means of cables and windlasses, the method of doing the work being as follows: Directly under the walls, 12x12 in. x80 ft. longitudinal timbers were placed. These timbers rested on transverse 12x12 in. timbers, which in turn rested on 14x14 in. longitudinal screw timbers. This portion of the timbering was placed before the building was raised. The screw jacks were then placed underneath the screw timbers, and the building raised so as to permit the placing of 12x12 in. shoe timbers and 12x12 in. track timbers. The pulling chains were attached to whiffletrees, which were strong timbers pivoted as the center so as to have a horizontal swing and which carried sheave blocks. The front whiffletree carried three blocks and the rear whiffletree four. The pulling chains passed around the screw timbers and also around the shore timbers. A dead man also carried seven blocks, and through these 14 blocks were sheaved, four cables each of which passed to a windlass. The windlasses were operated simultaneously by horsepower. The building was moved 32 ft. to the rear and raised 8 ins., the whole time required for laying track timbers, moving the building and raising it being two and a half 9-hour days. The power required to move the building is said to have been 800 tons.

Constant for Making Estimates for Sewers.—In making estimates for main and lateral sewers at Clinton, Iowa, Mr. Charles P. Chase, city engineer, derived a "constant" to show the cost of material and cost of laying the pipe. The estimate table shown herewith was used to derive this constant. It was obtained from the average of 51 miles of pipe sewers laid in five cities where physical conditions were similar to those at Clinton.

ESTIMATE TABLE TO DERIVE CONSTANT FOR PIPE SEWERS.

Size.	Cost of Pipe.	10% extra Y's.	Shipping loss and haul.	Cement and sand.	Laying.	Lights and watchman.	200 insurance	Injury to water cos.	Cost of $50,000 bond.	Foreman.	Total.	Interest and incidental.	Constant.
6″	$ .08	$.008	$.005	$.003	$.045	$.010	$.003	$.010	$.005	$.015	$ .169	$.0169	$ .186
8″	.116	.015	.012	.006	.045	.010	.004	.012	.005	.020	.265	.0265	.292
10″	.174	.023	.020	.009	.050	.010	.005	.014	.005	.045	.355	.0355	.381
12″	.2175	.028	.024	.010	.075	.015	.005	.016	.005	.060	.4545	.0454	.50
15″	.340	.040	.034	.013	.080	.017	.006	.018	.005	.065	.618	.0618	.68
18″	.51	.056	.046	.020	.085	.020	.007	.020	.005	.080	.849	.0849	.934
20″	.6825	.072	.057	.022	.100	.022	.007	.022	.005	.090	.9795	.0980	1.08
22″	.819	.122	.070	.030	.120	.025	.008	.024	.005	.10	1.323	.1323	1.46
24″	.975	.122	.080	.030	.130	.030	.009	.026	.005	.110	1.517	.1517	1.67
27″	.150	.15	.12	.036	.150	.040	.010	.028	.005	.125	2.164	.2164	2.38
30″	.160	.15	.14	.043	.180	.050	.015	.030	.005	.150	2.373	.2373	2.61
33″	2.25	.225	.14	....	....	.060	.015	.032	.005	.160	.....	.....	......
36″	2.70	.27	.15	.100	.10	.070	.020	.034	.005	.180	3.63	.360	3.99

Sand and Gravel Screening Plant.—In connection with the improvement of the Brighton Beach Line of the Brooklyn Heights R. R. Co., Brooklyn, N. Y., the contractor used an interesting sand and gravel-screening plant. This plant was described before the Brooklyn Engineers' Club by Mr. R. L. Russell, as follows: "We simply dug a hole in the ground and sheeted it and started a belt conveyor from the bottom of that hole running up to a screen over a bin, and on one side of the screen we brought the track up an incline to the receiving side of the hopper (that is, the hole in the ground) and all our spoil that had any percentage of gravel which would make it worth screening we simply shoveled off, or, in the case of dump cars, dumped into this hole in the ground and thus on to the belt conveyor and up to the screen. The other track we ran on the cast side of the screen bin and hopper and ran that down the grade, so that it was at a sufficiently low level below the bin to give us a free discharge from the bin without putting the latter at an excessive height. These two inclines, up on one side and down on the other, enabled us to build a bin at a height of only approximately 8 ft. above the original surface of the ground, instead of having to put it 20 or more feet in the air. In that way all the spoil from the work, after the installation of the screen, turned into gravel and into refuse material which went to the dump. We did not get any sand from this screen which was fit to use, on account of the percentage of loam mixed in with the sand and gravel. In addition to that, we had a good gravel pit immediately adjacent to this screening plant, and we simply put a mule and narrow-gauge side dumpers of 1 yd. capacity into this gravel pit and loaded the dump cars and hauled them up by the mule and dumped them into the same hopper with our spoil. We thus screened the gravel from the pit and from that we are now also getting sand of less than 4 per cent loam to use on the work. In order to clean the gravel at this screen, where the screening was not sufficient, instead of turning water through the screen we changed our discharging chutes from solid iron to perforated iron mesh and turned water over the gravel at the chute and the water and sand and loam goes off through the perforations in the chutes into a sluice and the washed gravel goes on to the cars."

During the past year there were built in German shipyards 435 steamships with a total of 311,105 gross register tonnage, and 516 sailing vessels aggregating 57,337 gross register tonnage, while 203 steamships (369,172 gross register tonnage) and 270 sailing ships (47,015 gross register tonnage) were on the stocks in course of construction at the end of 1907.

The British India Government realized from the forests let for revenue during the past financial year the net sum of $162,632.

The Cost of Building Electrical Conduits in Baltimore, Md.

In 1898 the electrical commission of Baltimore, Md., was organized to build a conduit system for the city, and thus compel all companies using the streets for poles to carry their wires, to take down these poles and place the wires underground. Prior to this several short lines of conduit had been laid in different sections of the city by some of the telephone and electric light companies, but the real work of building conduits began in 1898.

By law the electrical commission consists of the mayor, the city register and the president of the board of fire commissioners. Mr. Chas. E. Phelps, Jr., was appointed chief engineer, and has continued in this position, designing and building a system that to date has cost nearly $2,000,000. Through the kindness of Mr. Phelps, and from his reports as chief engineer, we are able to give the cost of all work done from 1898 to 1905 inclusive.

All the construction work has been done by day labor, but very careful cost records have been kept and the engineering general expenses have been recorded separately from the cost of construction. The organization of the department is shown by Fig. 1, which is a chart that is self explanatory. The materials, except those purchased in small amounts, are all bought by competitive bidding.

Chief Engineer. **Assistant Engineer**	**Plans and Data.**	Chief Draughtsman.	Draughtsmen. Linesmen.	Tracers Assistant Linesmen.
	Construction.	General Superintendent.	General Foreman. Assistant Superintendent. Material Man Foreman Teams and Storey'ds Gang Boss Distribution.	Foreman. Gang. Bosses.
	Operating and Maintenance, Cable Inspection.	Chief Cable Inspector.	Assistant Chief Inspector.	Foremen of Inspection. Gang Boss Rodding. Inspectors. Assistant Inspectors.
	District Inspection.	Chief Inspector.	Inspector Overhead Lines. Inspector Underground Lines	
	Paymaster and Records.	Paymaster.	Assistant to Paymaster. Paymaster's Clerk.	
	Office and Records.	Chief Clerk.	Bookkeeper. Stenographer. File Clerk. Office Clerk.	

Fig. 1—Organization Chart.

The construction work commenced March 1, 1899, the five months previous to that date being consumed in preparing plans and details of the system. The city conduit system, as a whole, is divided into two general parts, first, the trunk conduits, which are built for the purpose of carrying trunk lines and feeders, whether for telephone, telegraph, electric light, street railway or other service, located generally in thoroughfares, feeding different sections of the city. These trunk lines are laid out to serve these several territories by the most direct and feasible route. Second, as the system was originally designed, the central or congested district of the city was laid out to be served entirely underground, with underground connections, in each separate building. Extensions to this territory have been necessary. Figure 2 shows the service and distributing conduits on a section of a single street.

A high standard of work has been aimed at throughout the construction. Vitrified terra cotta conduit has been used in all conduit lines. This conduit is enveloped in concrete, which for the year 1899 and a part of 1900, was entirely of Rosendale cement. For the remaining period Portland cement has been used.

In 1899 the uniform thickness of this enveloping coat of concrete was 3 ins., except in a few cases where the bottom was made 4 ins. Since then the thickness has been increased, the sides and top being 4 ins., while the bottom has been from 4 to 6 ins. In all soft ground the bottom concrete has been reinforced with steel rods. The mixture for this work has been generally 1 : 3 : 6. The mixing has been done by hand only to a limited degree, the greater part of it being done with a Dromedary mixer drawn by a horse. The concrete is dumped on the ground by the mixer alongside the trench, and shoveled into place by the men laying the conduit. No forms are needed for this concrete under ordinary circumstances.

At the very beginning of the work the joints where the conduits knitted together, were wrapped with burlap 6 ins. wide, saturated in liquid asphaltum compound. The difficulty in making air and gas tight joints has always been recognized, and while continued efforts are made to secure this, it is realized that so far as gas is concerned, the best result obtainable is to minimize its entrance into the system.

Experiments along this line carried on during the year 1899 resulted in a composition of North Carolina pitch tar, refined asphalt and wax tailings, which has proven thoroughly serviceable. The use of burlap was entirely discontinued and cheesecloth substituted, the method of applying the joint being to paint the end of the conduit pieces with the hot compound where the wrapper is to be applied; the wrappers are rolled up and saturated in the hot compound and wrapped on while still hot. This joint is expensive, but it is believed that the results have justified its use.

In the construction of all lines of conduit, two or three fiber pipes, depending upon the importance of the line, are laid in the layer of top concrete for the purpose of providing some ready means for arc lights or similar connections from a point of the line remote from a manhole without building an extra manhole or breaking the line of vitrified pipe.

Manholes on trunk lines are all constructed of large size. A small conduit line, say of twelve ducts, would have a manhole, elliptical in plan, of a minimum of 5 x 8 ft., and of a suitable depth, depending upon the grade of the conduit, the minimum being 6 ft. The size of the manholes increases with the size of the line up to a plan section of 7 x 14 ft., which would be suitable for the largest line built, namely a line of 81 ducts. Figure 3, shows a standard plan of a brick manhole, with various styles of roof forms used. Similar manholes have been built of concrete.

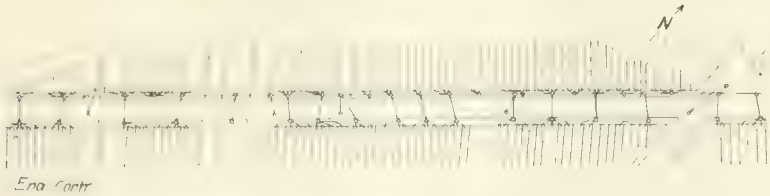


Fig. 2—Service and Distribution Conduits on a Single Street.

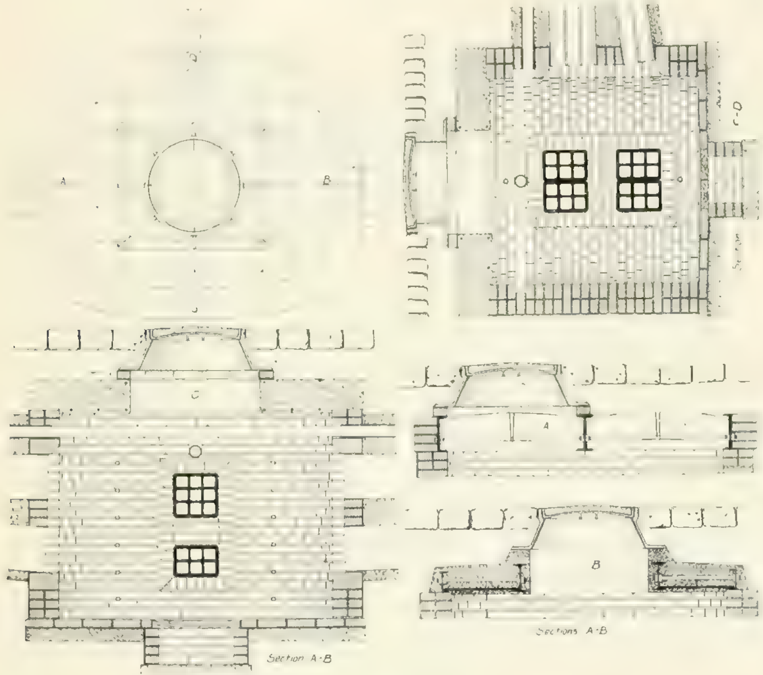


Fig. 3—Standard Plan of Brick Manhole.

On many of the important lines of conduit where it is possible for the operation of workmen in the streets to result in damage to the manholes, it has been the practice to construct the manholes of standard form, but of larger proportionate width, building one-half of the manhole a distance in advance of the other half along the line of conduit, so that lateral connections may be made from either half of the manhole either way without the necessity of crossing cables. The diagram of such a manhole built in concrete is shown by Fig. 4. In building manholes it has been the practice to clear all obstructions so that no pipes or other obstructions pass through the manholes. Thus nothing appears in the manholes except the cables for which they are built.

For concrete manholes for junction boxes and for distribution boxes, sectional wooden forms are made in a substantial manner, and these forms are used over and over again. In this manner the cost of forms has not been material.

In the central districts of the city it has been necessary to under drain, during construction, practically all lines of conduit, and the presence of tide water and the poor condition of small house drains in the street has necessitated making special provisions. There being no system of public sewers, and the storm water drains being on such shallow grades, it has rarely been possible to drain manholes by gravity. All manholes in the central district are drained by means of ejectors, operated by water pressure from the city mains. The practice followed has been to construct a sump in the center of the floor in each manhole of sufficient size to contain a valve operated by a float which controls the supply of water into the ejector. This is necessary to lift the water to a grade where it can flow by gravity.

The distributing system consists uniformly of a 10-duct conduit, laid 2-ducts deep and 5-ducts wide, encased in 4 ins. of Portland cement concrete, the earth covering being almost uniformly 19 ins.; the conduit line opening at intervals into service boxes which, when in sidewalks, are of terra cotta, circular in form and 36 ins. in diameter, having walls 2½ ins. thick, and a cast iron frame 5 ins. in depth to allow for sidewalk paving.

The main conduits, or trunk lines are laid in the streets or alleys, but many of the distributing ducts are laid under the sidewalks, and frequently on both sides of the street. The house connections are of fiber pipe, each connection consisting of two 2-in. and two 3-in. pipes; in some of the original work 1½-in. pipes were used for service connections, but the increase in size of service cables made it unwise to continue the use of this pipe.

Distribution boxes, see Fig. 5, in the street proper, are built of brick or concrete, elliptical in form. These boxes have a frame casting similar to that used on manholes, but smaller and lighter.

At the intersections of distributing lines, junction boxes are built of concrete or brick, see Fig. 6. On distribution and junction boxes of all types, the frame casting is set directly on the walls, no special roof construction being required.

The digging of the trenches is all done by hand. The trenches for the trunk line vary in width and depth. In depth they run from 3 to 12 ft. deep, being on an average of about 6 ft. In width they run from 2 ft. to 4 ft. For the distributing conduits the trenches are all of the same depth, about 3 ft., and they are about 2 ft. wide. In the cost of excavation are included labor (both men and teams), timbering, drainage, clearing away obstructions, back filling, in fact all the cost of excavating from tearing up the paving to turning the ditch over to the pavers. In many sections of the city, trenches 5 ft. or less in depth need but little timbering.

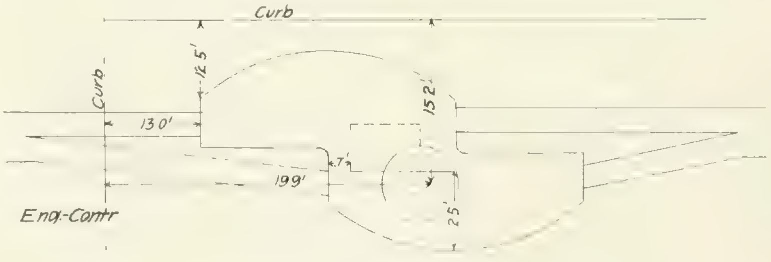


Fig. 4—Diagram of Concrete Manhole.

The foregoing describes the general conditions of the work and illustrates the method and plans used. A careful and well devised system of unit cost keeping is employed and from these records the following costs for 7 years of work have been compiled. In considering them the organization of forces and the cost keeping system must be explained.

The system followed in organizing the work has been to divide it into two principal parts: First, the part known as "General expenses and Monthly Payroll," and, second, "Construction Costs and Weekly Payroll." Under the latter is charged all costs and expenses which would be borne by the contractor were the work done under contract; under the former heading is charged all items of salaries and expenses which would represent the cost to the city of administering the work and doing the necessary engineering were it done under contract.

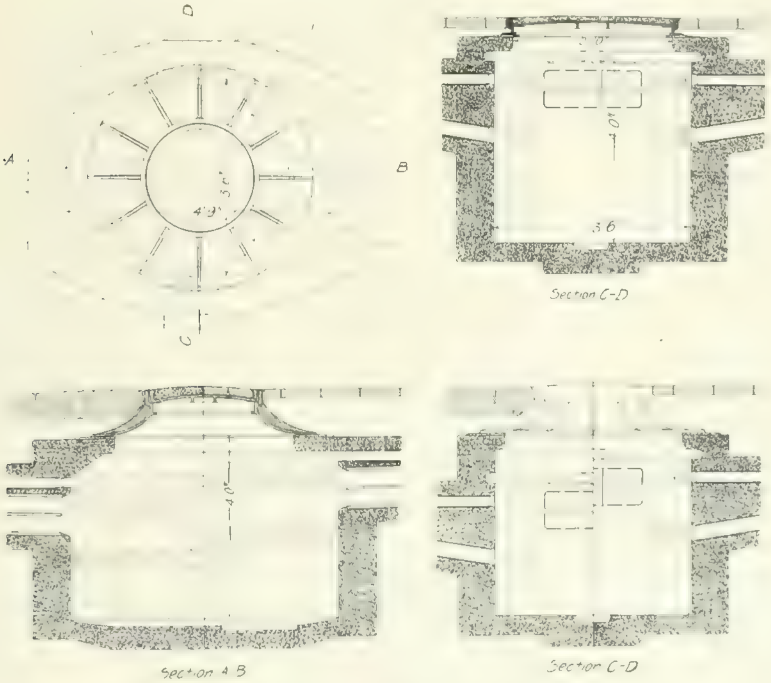


Fig. 5—Distribution Boxes.

Referring to Fig. 1, showing the organization chart, the expenses of organization and monthly expenses include the headings of "plans and data" and "office and records." "Construction" and "paymaster and records" go to make up the construction cost, with the addition of materials. The items of "Operating and Maintenance," "Cable Inspection" and "District Inspection," are separate accounts that do not enter into the cost of construction.

All foremen and regular employes are charged under their specific subdivisions as governed by the plan of the organization. Watchmen and similar expenses in construction which cannot be readily subdivided, are charged under the general head of "Weekly Material, Tools and Labor," which is an expense account.

Labor is checked out and is designated by numbers, and also by letters, indicating the particular subdivision under which it will be charged, the man himself carrying a brass check showing the number and letter. Each laborer also carries a time ticket for each week, on which is punched by the timekeeper, four times each day, the hours at which time is taken. In this way the man carries his own time, and any dispute with the timekeeper is avoided.

All material as purchased is charged to the "storeyard account," under the subdivision "Weekly M. T. & L.," and, when used upon the work, is then charged to the particular subdivision in which used, and credit given the storeyard.

A man is sent to each construction gang, termed a "lineman," whose duty it is to be the connecting link between "plans and data" and "construction," or, in other words, he reports upon printed blanks daily to the chief clerk the labor in each subdivision. In addition to this, he records the dimensions, both with regard to the construction work proper, and also all foreign structures met with in the course of the work. These latter data are turned into the chief draftsman, where after being checked, they are entered in colors upon permanent plats drawn to the scale of 20 ft. to 1 in.

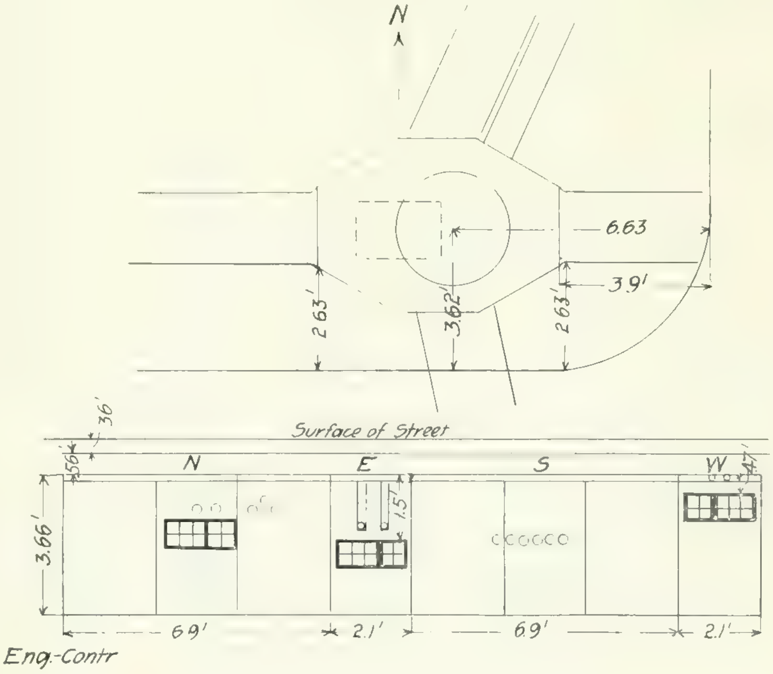


Fig. 6—Junction Boxes.

All of these reports are tabulated in the office and monthly summaries made. Permanent entries of the costs under each subdivision are made at the end of each month.

Up to Jan. 1, 1906, the summary of all conduit construction was:

	Duct Feet.
New Conduit, including Specials....	5,330,089.50
Replaced in 1904-1905............	191,853.70
Replaced for account Consolidated Gas Company, Gay street.......	79,578.00
Special, for account Sundry Parties	46,053.23
Grand Total..................	5,647,574.43

The wages paid to men and teams are shown by Table I. Table II shows the prices of materials for each year.

In addition to materials, Table III also shows the cost of tools. In the third column from the end will be found "amount charged to depreciation, breakage, material and tools." In addition to the ordinary breakages and waste of material and tools, it has been the custom to charge off each year 20 per cent on the heavier construction equipment. Such small tools as shovels, picks, etc., the actual depreciation is charged off, because of the short life of such tools. The comparatively large amounts charged off in 1904 and 1905 are accounted for by reconstruction of the conduits in the burnt district, where a much larger percentage of material was naturally lost. It will be remembered that in

February, 1904, Baltimore suffered from a fire that destroyed a large section of the business part of the city.

TABLE I.——WAGES PAID LABOR

Year.	Rate per hour, foreman.	Rate per hour, gang boss.	Rate per hour, pavers.	Rate per hour, brick-layers.	Rate per hour, rammers.	Rate per hour, carts.	Rate per hour, pipe layers.	Rate per hour, 2-horse teams.	Rate per hour, labor.
1899	$0 37½	$0 31¼	$0 43¾	$0 43¾	$0 31¼	$0.31¼	$0 25		$0 20⅝
1900	37½	31¼	43¾	.43¾	.31¼	28⅛	25	$0 37½	20⅝
1901	37½	31¼	.43¾	.43¾	31¼	.28⅛	25	37½ June 28 .40⅝	20⅝
1902	37½	31¼	.43¾	.43¾ April 25 .50	31¼	28⅛	25	40⅝	20⅝
1903	.37½ April 10 43¾	31¼	.43¾	50	31¼	.28⅛	25	.40⅝ August 21 .45⅝	20⅝
1904	43¾	31¼	.43¾	50 July 1 .56¼	31¼	28⅛ April 15 .31¼	25	45⅝	20⅝
1905	43¾	31¼	.43¾ April 5 50	.56¼ April 5 .62½	.31¼ April 5 37½	31¼	25	.45⅝	20⅝

The effect of this great fire on the conduit system was quite surprising, as it did but little damage. The trunk lines and the cables in them were uninjured, in spite of the intense heat and the enormous weight of debris, consisting of masonry and iron that fell on them. The piles of debris in some cases were 10 and 12 ft. high. A few service box covers were broken by falling walls.

TABLE II —PRICES OF MATERIALS.

Year.	Brick Delivered on Line.	Cement.			Terra Cotta Conduit. f. o. b. Balto.			Fibre Conduit f. o. b. Balto.		Fibre Bends f. o. b. Balto.		Lumb'r Delv'd on line.	Sand Delivered on Line.	Crush'd Stone Del'v'd on line.	Castings Delivered at Storeyard.			
	Per 1,000 Arch	Per bbl Rosendale.	Per bbl. Toltec "slag"	Per bbl Portland	Per duct foot 4 duct.	Per duct foot 6 duct.	Per duct foot 9 duct.	Per duct foot 2 in.	Per duct foot 3 in.	Per length, 5 ft. 2 in.	Per length 5 ft 3 in	Per 1,000 ft. 2 x 12.	Per ton 2,240 lbs	¾-in., per ton of 2,240 lbs.	Per pair 1-M & 2-M	Per pair 3-D & 4-D.	Per pair 8-D & 9-D.	per pair 11-D & 12-D
1899	$5 70	*$ 84		.	$ 066	$.0667	$ 068	$ 045	$ 049	. . .		$13.50	$ .60	$ 93	......	.	$5 25	$12.24
1900	7.75	* 81	$* 82	*$1 38	.066	.0667	.068	.05	.05		. .	15 00	Dist. 1, .60 " 2, .63 " 3, .64 " 4, .74	1.49	$16.37	$9.59	5.25	12.24
1901	6 50		*.78	*1.70	.066	.0667	.068	.05	.05	‡.45	‡$ 50	12.49	.73	1 40	16 37	8 62	5 25	12 24
1902	6 50		†.90	*1.35	.066	.0667	.068	.05	.05	‡ 45	‡ 50	14 50	83	1.39	......	8 62		
1903	7 20		*1 06	*2 00	.066	.0667	.068	045	.05	‡.45	‡ 50	17 00	‡ 89	‡1.48	19 11	14 03		
1904	‡7.50		† 90	†1.35	0325	.0375	.0375	.04	.0425	‡ 45	‡ 50	‡.1700	‡ 87	‡1.50	19 11	14 03		
1905	‡5.70		†.90	†1.18	.04125	.045	0475	045	05	‡ 45	‡ 50	‡17 00	‡.78	1 585	.	‡10 00		

‡ Bought in open market. * Delivered on line. † F. O. B. cars, Baltimore.

Likewise the distributing system was uninjured except in a few places caused by gas explosions. When it is remembered that only 19 ins. of earth covers these conduits and they are frequently broken by service boxes, it is a matter of surprise that the conduits were not injured. The cables in them were only injured where they entered the destroyed houses.

TABLE III —COST OF ALL MATERIALS USED.

Year.	Store Yard Material purchased at end of each year.	Tools purchased and repairs at end of each year.	Total Store Yard material and tools.	Cost of Materials and Tools Used in Trunk Lines.*						Cost of Material Used in Service and Distribution.†							Total cost of material used in trunk lines and service and distribution.	Inventory of material in store yard at end of each year.
				Excavation.	Concrete	Man-holes	Conduit	Special Construction	Tools and repairs.	Excavation	Concrete	Service boxes.	Conduit	Pole connection.	Arc light construction	Depreciation, breakage, material, tools.		
1898 1899	$202,213.15	$8,987.50	$211,200 65	$2,232 01	$10,418.68	$3,628.17	$102,213.62	$144.63	$4,797 59	$32 81	$184.27	....	$1,400.25	.	.	$ 116.02	$131,168.05	$80,032.60
1900	208,203 53	10,651.87	218,855.40	711.72	8,313.74	2,055.69	40,887.17	7,109 17	4,780.79	196 02	1,965.48	$1,539.73	6,709.63				74,269.14	144,586.26
1901	180,756.80	10,929.16	191,685 96	284 01	6,500 21	5,261.32	24,642 92	413.87	1,735.88	440.77	10,425.15	4,479.51	28,249.43	$980.83	$447.45	377 60	84,238.95	107,447.01
1902	121,705.80	10,977.67	132,683.47	332.62	4,929.74	1,511.86	26,166 20	1,999.86	1,466 88	286 99	5,456.53	2,196.22	14,139.30	122.40	1,455.87	120 50	60,184.97	72,498.50
1903	87 238 25	11,541.95	98,780.20	1,050.11	8,596.46	3,349 80	24 889 90	1,297.82	2,352 95	41 77	253.42	51 28	412 26	532 21	142 22	106 99	43,077.19	55,703.01
1904	82 683 04	12,503.78	95,186.82	148 12	1,578.97	580.79	5,847.24	11,999.41	2,082 50	917 98	6,790 68	6,743.20	20,467.37	604.02	107.09	1,765.90	60,285.68	34,901.14
1905	89,141.23	16,325.61	105,466.84	604 06	9,917.93	5,212.30	20,046.35	12,754.77	4,303.37	262.12	3,309.53	3,950.31	6,310.34	113.03	30.99	2,021.60	74,618.88	30,849.96

* Under this head there was an item of $445.63 for paving in 1905, and following items of General Expense, M. T. & L.: 1904, $652.41; 1905, $4,283.05.
† Under this head there was an item of $1,051.50 for paving in 1905.

As gas pipes were broken throughout the entire burnt over area, there was apprehension that gas would collect in the system and explosions occur, but so well had the ventilation of the system been planned, that no serious trouble of this kind occurred, the operating department taking prompt steps to prevent the gas from collecting in the system.

Nevertheless the fire caused much extra work to be done as the pole and house connections were destroyed, and not only new ones had to be made, but in rebuilding the city, many changes were necessary to meet new conditions. The cost of this work shows up in the tables under the years 1904 and 1905.

Table IV shows the details of the construction account, giving the duct feet of conduit laid, divided into terra cotta and fibre, also the number of manholes, service and junction boxes, house connections, and also special construction work, which is paid for by parties ordering it. The cost per duct foot is given.

Table V is a general summary of all the costs of work for each year, taken from ledger accounts shown in cost per duct foot. Under "general expense and monthly payroll" are given the expenses that would be known as the administration expenses of the commission having in charge the work, and engineering expenses, if the work was done by contract, while under "construction and weekly payroll" are given the expenses that would be the contractor's cost. It will be noticed that the general and monthly expenses are divided equally between the trunk and distribution conduits, while the construction expenses are actual figures of cost for each. Under monthly and weekly "M. T. & L." are listed all items that cannot be readily distributed. In the column headed "Preliminary Expenses" are expenses incurred in planning and designing work for the succeeding construction period. Under "organization" is listed the expense of the commission and the chief and assistant engineers. At the end of the table is given the cost per duct foot for each year, showing the cost of construction, the preliminary expenses, and the general expenses, including the engineering supervision.

TABLE IV.—SHOWING DETAILS OF GENERAL CONSTRUCTION ACCOUNT.

Year	Trunk Conduit					Service and Distribution							Total duct feet Main and S. & D. Constructed.	Net cost per duct foot.	Construction on Special Account.												GrandTotal duct feet Constructed.
	Duct feet					Duct feet.									Duct feet.												
	Terra Cotta.	Fibre	Total.	No. of Manholes.	Per duct foot.	Terra Cotta.	Fibre.	Total.	No. of service boxes.	No. of junct. boxes	No. of house conns.	Per duct foot.			Terra Cotta.	Fibre.	Total.	No. of Manholes	No. of junct. boxes.	No. of service boxes.	No. of house conns.	Arc light conns.	Trolley pole conns.	Fire alarm conns.	Police call conns.	Miscellane's conns.	
1898 1899	1,546,309 5	36,050.1	1,582,359 6	145	.1810	20,333 6	......	20,333 6	1	....	4	.1532	1,602,693.2	.1804	1,958	152.	2,110.			26							1,604,803 20
1900	546,188 2	57,099 0	603 287 2	78	.1975	82,470 8	19,262 2	101,733 0	81	65	263	2771	705,020 2	2323	76,101	18,253 93	94,354 93			10							799,375 13
1901	327,799 4	53,451 7	381,251 1	57	2145	298,846 9	155,342 3	454,189 2	286	92	945	2240	835,440 3	2200	1,277.	1,606	2,883	7		33							838,323 30
1902	340,336 9	58,330 6	398,667 5	47	1689	151,342 8	74,669 6	226,012 4	144	50	429	2011	624,679 9	.1807	7,689.	4,295 30	11,984 30										636,664 20
1903	310,281 1	45,658 2	355,939 3	72	2670	10,709 9	6,792.6	17,502 5	2	2	8	2350	373,441 8	.2360	6,444	3,155.	9,599	1		6			39				383,040 80
1904	78,588 8	6,537 6	85,126 4	18	2328	209,223 8	123,006 5	332,230 3	192	70	677	2284	417,356 7	2160	54,589 8	25,045.	79,634 80	1	21	42	216	178					496,991 50
1905	514,898 0	57,394 8	572,292 8	87	1701	106,650 6	73,097 4	179,748 0	163	40	474	2460	752,040 8	1848	82,347.	53,988 5	136,355 50	3	7	24	406	72	1	11	5	32	888,376 30
Total.	3 664,401 9	314,522 0	3,978,923 9	504	1926	879,578 4	452,170 6	1,331,749 0	869	319	2800	2272	5,310,672 9	2009	230,405 8	106,495 73	336 901 53	12	28	141	622	250	40	11	5	32	5,647,574 43

TABLE V.—SHOWING UNIT COST OF EACH ITEM OF GENERAL EXPENSE AND CONSTRUCTION.

	Year	Total duct feet	General Expenses and Monthly Pay Roll.						Construction Cost and Weekly Pay Roll.								Terminal pole Connections	Arc Light Connections.	Total Construct'n expense	Total cost for each year.			
			Organization	Office.	Plans.	Monthl' M. T. & L.	Total General Expen's	Preliminary Expen's	Excavation.	Concrete.	Manholes.			Conduit	Paving	Weekly M. T. & L.							
			Per duct foot	Per duct foot.	Per duct foot.	Per duct foot.	Per duct foot.	Per duct foot.	Per duct foot.	Per duct foot.	No.	Per hole	Per duct foot.	Per duct foot.	Per duct foot.	Per duct foot.	Per duct foot	Per duct foot.	Per duct foot.	Construction.	General expenses.	Preliminary expenses	Totals
Trunk	1898 99	1,582,359 60	0059	0028	.0035	0065	.0187	.0051	.0513	.0115	143	$251 36	.02	.0778	008	.0124			181	181	.0187	.0051	.2048
	1900	603,287 20	.0108	0049	0068	.0054	0279	.0147	.0367	.0217	58	227 96	0219	0825	0102	.0245			.1975	1975	.0279	.0147	2401
	1901	381,251 10	009	0041	.0047	0066	0244	0103	.0354	0212	58	248 63	.0378	0735	0103	.0283	.0054	0026	.2145	2145	0244	.0103	.2492
	1902	398,667 50	0121	0038	.0063	.0066	.0288	0135	.03	0154	43	154.06	0166	0711	0059	.0206	.0008	0085	.1689	1689	0288	.0135	.2112
	1903	355,939 30	0163	0092	.0094	.0081	043	0151	.0632	.0297	72	234.90	.0475	075	013	.0312	0036	.0014	.2646	2646	043	.0151	.3227
	1904	85,126 40	0091	.0092	.004	.0237	046	.0117	0362	.0246	18	129.81	.0274	08	0141	.0505			.2328	2328	.046	.0117	.2905
	1905	572,292.80	.0051	0065	.003	029	0436	.0082	.0447	.0241	85	188 63	.028	0438	009	.0205			.1701	1701	.0436	.0082	.2219
			0088	0048	.0048	.011	.0294	.0098	.0452	.0182	477		0252	.0726	.009	.0203	.0009	0012	.1926	1926	.0294	.0098	.2318
Service & Distribution	1898-99	20,333 60	0059	0028	.0035	.0065	.0187	0051	.051	.0145				.0794	008				.1532	.1532	.0187	.0051	.1770
	1900	101,733 00	0108	0049	.0068	.0054	.0279	.0147	.0851	.0269	120	$ 41.70	0492	.0778	0178	.0203			2771	.2771	.0279	.0147	.3197
	1901	454,189 20	009	0041	.0047	.0066	.0244	.0103	.0646	.03	396	42.70	.0372	.07	.0084	.0138			.224	.224	0244	.0103	.2587
	1902	226,012 40	0121	0038	.0063	.0066	.0288	.0135	.0465	.0294	215	32 81	0312	.0691	0125	.0124			2011	.2011	0288	.0135	.2434
	1903	17,502 50	0163	0092	.0094	0081	.043	0151	.065	.018	4	142 54	.0326	.075	0237	.0574			.2717	.2717	.043	.0151	.3298
	1904	332,230 30	0091	0092	.004	.0237	.046	.0117	.0487	.0272	262	57.81	0456	.0693	.0177	.0142	.0038	.0019	2284	.2284	.046	.0117	.2861
	1905	179,748 00	.0051	0065	.003	.029	.0436	.0082	.061	.0263	203	55.95	.0632	.0433	.0286	.02	.003	.0006	.246	.246	.0436	.0082	.2978
			.0088	.0048	.0048	.011	0294	.0098	.0583	.0281	1200		.0421	.0663	.015	.0154	.0014	.0006	.2272	.2272	.0294	.0098	.2664

TABLE VI.—SHOWING PER CENT OF LABOR AT UNIT COSTS.

	Year	General expenses and monthly pay roll.	Construction expense and weekly pay roll.			Construction expense and weekly pay roll.			Construction expense and weekly pay roll.			Average total unit cost at end of year.				
			Excavation.	Concrete.	Manholes	Conduit.	Paving.	Weekly M. T. & L.	Pole connections.	Arc light.	Grand total.					
		Salaries.	Labor A.	Labor B	Labor C.	Labor. D.	Labor I.	Lab.M.T.& L.	Labor P.	Labor L.	Labor.	Trunk.	S. & D.	Gen Exp.	Prel Exp	Total.
		Per cent.	Per cent.	Per cent	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.					
Trunk Conduits	1898-99	84	96	43	65	9 8	78	54			48	.181		0187	0051	2048
	1900	88	88	37	61	16	66	56			45	.1854		0215	.008	.2149
	1901	91	91	19	40	8 4	69	47	52	39	38	.1896		0223	0086	.2205
	1902	93	96	19	52	5 6	89	78	60	56	42	.1869		.0234	.0094	2197
	1903	91	93	19	65	7	75	82	58	69	51	.1954		0252	0099	2305
	1904	85	81	24	52	12	69	23				.1964		0271	0101	2336
	1905	71	97	27	63	15	90	50			54	.1926		0294	0098	2318
	Av per cent.	85	95	30	59	11	77	58	56	54	47					
Service and Distribution.	1898-99	84	97	37		11	83				46		1532	.0187	.0051	.177
	1900	88	98	28	55	14	100	99			60		.2564	.0216	008	2860
	1901	91	98	24	59	9 5	99	100			54		.2307	0223	.0086	2616
	1902	93	97	18	53	7 8	83	100			47		2224	.0233	.0094	2551
	1903	91	96	21	86	9 1	90	100			79		.2226	.0251	.0099	2576
	1904	85	94	25	47	09	90	100	51	81			.2252	.0270	.0101	2623
	1905	71	95	29	64	16	79	96	80	72	64		.2272	0294	.0098	.2664
	Av per cent	85	97	24	57	10	89	99	60	80	56					

Table VI indicates the percentage of labor on the total cost under each subdivision of the work. This account is kept for readily analyzing the unit costs given in Table IV.

Tables VII and VIII show the cost of earth excavation. All the material is earth, but it varies much, there being sand, loam, clay, debris of made ground, and black mud. These costs, as stated, include timbering, drainage, clearing away obstruction, back filling and all items of digging and finishing the trench to be turned over to the pavers.

TABLE VII. NUMBER CUBIC YARDS OF EARTH EXCAVATED EACH YEAR

Year	1899	1900	1901	1902	1903	1904	1905	1906	1907
Total	31097.74	11862.44	7155.22	6561.07	11590.45	1720.73	15476.20	9984.83	5687.13

TABLE VIII. SHOWING COST PER CUBIC YARD OF EARTH EXCAVATION FOR EACH MONTH

Month	1899	1900	1901	1902	1903	1904	1905	1906	1907
January								$2.48	$2.22
February								1.26	2.12
March								1.09	1.38
April	$1.36			$1.34	$1.85		$2.95	1.04	1.45
May	2.88	$1.48	$2.12	1.44	1.61		1.64	1.61	1.28
June	2.88	1.74	1.46	1.84	2.28		1.40	1.54	1.62
July	3.73	1.64	1.22	2.02	2.09	$32.02	1.85	1.58	
August	2.60	2.81	1.80	1.44	2.13	1.30	2.00	2.01	
September	2.41	2.50	2.30	2.11	1.73	1.53	1.25	1.41	
October	2.40	1.40	12.48	2.50	2.30	1.71	1.32	1.98	
November	2.28	4.10			1.50		1.20	1.61	
December	3.00	1.58	4.54		1.85		1.70		
Average each year	$2.61	$1.87	$1.88	$1.82	$1.94	$1.79	$1.65	$1.53	$1.49

The item in July, 1904, of $32.02 per cu. yd., was especial emergency work, caused as a result of the fire of 1904, and bears no relation to the general work, being given to complete the record. The cost of excavation is not only given for the years of 1899 to 1905, inclusive, but also for 1906 and up to June, 1907.

The average cost of the trunk lines for the entire construction period is given below per duct foot for each item, and also the per cent that each item is of the total average cost:

	Per duct foot	Per cent
Organization	$0.0088	3.8
Office	0.0048	2.1
Plans	0.0048	2.1
Month M. T. & L.	0.0110	4.8
Preliminary Ex.	0.0098	4.2
Excavation	0.0452	19.1
Concrete	0.0182	8.
Manholes	0.0252	10.9
Conduit	0.0726	31.4
Paving	0.0090	3.9
Weekly M. T. & L.	0.0203	8.8
Terminal Pole Con.	0.0009	0.4
Arc Light Con.	0.0012	0.5
Total	$0.2318	100.0

The average cost of the service and distribution lines itemized with percentages is also listed.

Average itemized cost of service and distribution lines:

	Per duct foot.	Per cent.
Organization	$0.0088	3.3
Office	0.0048	1.8
Plans	0.0048	1.8
Monthly M. T. & L.	0.0110	4.1
Preliminary Ex.	0.0098	3.7
Excavation	0.0583	21.4
Concrete	0.0281	10.6
Manholes	0.0421	15.8
Conduit	0.0663	24.9
Paving	0.0150	5.6
Weekly M. T. & L.	0.0154	5.8
Terminal Pole Con.	0.0014	0.5
Arc Light Con.	0.0005	0.2
Total	$0.2664	100.0

It will be noticed that the cost of the conduit material runs from about 25 to 30 per cent of the total cost.

Cost of Treating Piling with Teredo Proof Paint.

A contractor, doing work for the U. S. Government in the Gulf of Mexico, has furnished the following data:

The laborers were paid 15 cts. per hour, and a foreman superintending the work was paid 50 cts. per hour. The foreman and laborers were furnished subsistence and beds at a cost of 50 cts. per day per man. The piles were 60 ft. long, but only 50 ft. of their length was treated, because the smaller end was driven into the ground for more than 10 ft. The piles were usually large and were Florida yellow pine. The cost of treating them was as follows:

Barking the piles 2.27 cts. per lin. ft. Painting the piles with Teredo Proof Paint, three coats, 2.17 cts. per lin. ft. The paint cost 3.91 cts. per lin. ft. There was used only about 1½ gills of paint per lineal foot of piling for the entire three coats. That would be an average of ½ gill or ¼ pint for each coat. Of course the first coat took more than the second, and the second more than the third. The total cost was 8.35 cts. per lin. ft. for material and labor. The contractor states: "I am of the opinion that an additional coat, making four in all, would be advantageous and that the total cost would not then exceed 9½ cts. per lin. ft." The paint was furnished by the Teredo-Proof Paint Co., 17 Battery Place, New York.

A Slide Rule for Structural Designing.

Unlike the ordinary slide rule, which is flat, this rule, is a triangular scale and calculating rule in one, architectural scales being on the edges of the rule, while the faces are occupied by logarithmic slide rules. The slide rules embrace not only the ordinary Manheim slide rule but also a column slide rule as well as a beam slide rule. The rule is 15 ins. long instead of the usual 10 ins., thus allowing of wider divisions, and therefore of great accuracy in reading.

This rule is designed especially for structural work, and, as stated, two of the three sides are given over to this purpose. For columns and compression members this slide rule is designed to show the allowable stress in accordance with the formula.

$$S = 15{,}200 - 58\frac{L}{r}$$

S = stress in pounds for square inch.

L = unsupported length of column.

r = radius of gyration of the column section.

The beam slide rule is designed for the solution of problems relating to the strength of beams carrying uniformly distributed loads. For concentrated loads it is necessary to calculate the bending moment.

This rule is the invention of Mr. John L. Hall. It is stated that it has been in use in a leading engineering office for more than a year, and has proven itself a highly satisfactory labor saving device. Mr. Hall has written a small 54-page manual explaining the use of this slide rule for various purposes, giving the solution of numerous problems.

The rule is for sale for $6, by the Slide Rule Club, P. O. Box 12, Station J, New York City. The price of the slide rule manual is 50 cts.

A report on the excavation done by the U. S. Reclamation Service by force account of 100,035 cu. yds. of material in East Branch Canal, Klamath Project, prior to June 30, 1907, gives an average cost of $0.24, $0.47 and $1.33 per cubic yard for Classes 1, 2 and 4 respectively. Of this material 91,224 cu. yds. were Class 1, 8,624 cu. yds. Class 2 and 187 cu. yds. Class 4. The material is classified under the classes given in Specifications No. 96. The unit prices given include preparatory expenses, plant depreciation and all engineering and administrative expenses. The Monthly Bulletin of the service states that "owing to the smallness of the working forces, the necessity for using hired teams and the keeping of idle stock during a portion of the time, the above prices are somewhat in excess of what they would have been had these conditions been more favorable during the progress of the work."

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review, timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are: First, to inform civil engineers and contractors of the articles and papers of merit, that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING-CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in.; 15 cts.
American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.
American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y.; m; 7x10 in.; 20 cts.
American Engineer and R. R. Journal (Am. Engr. & R. R. Jl.), York, N. Y.; m; 7x10 in.; 20 cts.
American Gas Light Journal (Am. G. L. Jl.), New York, N. Y.; w; 10x13 in.; 10 cts.
American Machinist (Am. Mchst.), New York; w; 7x10 in.; 15 cts.
Annales des Ponts et Chaussees (An. P. & C.), Paris, France; m.
Architects and Builders Journal (Arch. & Bldrs. Jl.), Baltimore, Md.; m; 9x12 in.; 20 cts.
Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.
Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
Bulletin International Railway Congress (Bul. Int. Ry. Cong.), Brussels; m; 50 cts.
Bulletin U. S. Geological Survey (Bul. Geo. Surv.), Washington, D. C., 4x7 in.
Bulletin U. S. Department of Agriculture (Bul. Dept. Agr.), Washington, D. C.; 4x7 in.
Bulletins Railway Engineering & Maintenance of Way Association (Bul. Am. Ry. Eng. & M. of W. Assoc.).
California Journal of Technology (Cal. Jl. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.
Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x10 in.; 20 cts.
Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.
Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.
Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.
Canadian Mining Journal (Can. Min. Jl.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.
Canadian Municipal Journal (Can. Mun. Jl.), Montreal, Que.; m; 6¾x10 in.; 10 cts.
Carpentry and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.
Cassier's Magazine (Cas. Mag.), New York, N. Y.; m; 5x8 in.; 25 cts.
Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.
Cement Age (Cem. Age), New York, N. Y.; m: 4x7 in.; 10 cts.
Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.
Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.
Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.
Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.
Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.
Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.
Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.
Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.
Concrete and Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.
Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.
Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.
Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.
Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.
Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.
Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.
Electric Railway Review (Elec. Ry. Rev.), Chicago, Ill.; w; 7x10 in.; 20 cts.
Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electric Traction Weekly (Elec. Trac. Wkly.), Cleveland, O.; w; 7x10 in.; 10 cts.
Engineer (Engr. Lon.), London, England; w; 4x11 in.
Engineer, (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Engineering (Eng.), London, England; w; 8x11 in.
Engineering Digest (Eng. Dig.), New York, N. Y.; m; 5x8 in.; 20 cts.
Engineering-Contracting (Eng.-Contr.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Engineering and Mining Journal (Eng. & Min. Jl.), New York, N. Y.; w; 7x10 in.; 15 cts.
Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.
Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.
Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.
Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.
Le Genie Civil, Paris, France; w.
Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.
Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.
Industrial World (Ind. Wld.), Pittsburg, Pa.; w; 7x10 in.; 10 cts.
Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; $1.
Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.
Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.
Iron Trade Review (Iron T. Rev.). Cleveland, O.; w; 7x10 in.; 15 cts.
Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.
Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.
Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.
Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.
Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.
Journal of Electricity, Power and Gas (Jl. Elec., P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.
Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.
Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.
Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Mines and Minerals (Mi. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.
Mining and Scientific Press. (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.
Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.
Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Modern Machinery (Mod. Mchy.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Municipal Journal and Engineer (Mun. Jl. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.
Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.
Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.
Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w; 9x11 in.; 15 cts.
Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.
The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 ins., 15 cts.
Power, New York, N. Y.; m; 7x10 in.; 20 cts.
Proceedings American Institute of Electrical Engineers (Proc. Am. I. of E. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings American Society of Civil Engineers (Proc. Am. Soc. C. E.), New York, N. Y.; m; 4x7 in.; 75 cts.
Proceedings American Society of Mechanical Engineers (Proc. Am. Soc. M. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings Engineers' Club of Philadelphia (Proc. Engrs.' Club, Phila.), Philadelphia; qr.; 4x7 in.; 25 cts.
Proceedings Canadian Society of Civil Engineers (Proc. Can. Soc. C. E.), Montreal; m; 4x7 in.; 50 cts.
Railroad Gazette (R. R. Gaz.), New York; w; 8x11 in.; 15 cts.
Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.
Railway Age (Ry. Age), Chicago, Ill.; w; 7x10 in.; 10 cts.
Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.
Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.
Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.
Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Roadmaster and Foreman (Rd. & For.), Chicago; 7x-0 in.; 10 cts.
Rock Products (Rk. Prod.), Chicago, Ill.; bi-w.; 9x11 in.; 10 cts.
Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.
School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr.; 4x7 in.; 30 cts.
Schweizerische Bauzeitung, Zurich; w.
Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.
Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.
Sibley Journal of Engineering (Sib. Jl. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.
Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.
Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.
Street Railway Journal (St. Ry. Jl.), New York, N. Y.; w; 7x10 in.; 10 cts.
Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.
The Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.
Waterproofing (W. P.), New York, N. Y.; m; 5x8 in.; 10 cts.
Zeitschrift d. Oest. Ing. u Arch. Ver Vienna; w.
Zeitschrift d. Ver Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

Method and Cost of Road Treatment With Tar and Oil in Rhode Island. By A. W. Blanchard. Engr.-Contr., March 25, 1908; 2 2-3 pp.

Describes at length the various systems of oil treatment that have been tried, giving character of materials and methods of application. An interesting general account of work actually done in tar and oil treatment of roads.

The Economics of Snow Removal and a Suggested Improvement Over the Present Methods Used in New York. By Richard T. Dana. Engr.-Contr., March 4, 1908, 1 p.

The author criticises the present method of measuring up and paying for snow removal and outlines an improved method which would allow of exact account being kept and of the contractor being fairly paid for his work without placing a premium on delay. A suggestive article to city engineers and superintendents of street cleaning.

Tables for Estimating the Quantity of Materials and Cost of Gravel, Sand and Oil on Roads and Streets of Different Widths. Engr.-Contr., March 4, 1908; ½ p.

These tables give cost of gravel in cents per square foot of surface at various prices per cubic yard and spread 1 in. deep, cost of oil in cents per square foot at various prices per barrel and quantities of oil per square yard, lineal feet of street covered by one barrel of oil with various widths of roadbed and quantities of oil per square yard, and linear feet of street covered by one cubic yard of gravel spread one inch deep on various widths of roadbed.

Object Lesson Roads Built in 1906-7 by U. S. Office of Public Roads With Data on Costs. Engr.-Contr., March 4, 1908; 2 pp.

Describes the construction of each of the 16 object lesson roads constructed during 1906-7 by the U. S. Office of Public Roads and gives costs and wages of labor. The roads comprise macadam, gravel, shell, earth, sand-clay and cement-clay constructions. A valuable article for road builders.

Wood Paving in the United States. By C. L. Hill. Forest Service Circular, No. 141; 24 pp.

The subject of wood paving is discussed at some length, giving the history and the progress made in this country and Europe. The selection of wood, laboratory tests, creosoting, foundation, blocks, angles of courses, joints filler and top dressing, are discussed. Maintenance is also commented upon and other details. A very valuable and interesting paper.

Some Points in Road Construction. By E. B. B. Newton. Surveyor, March 13, 1908; 1½ pp.

A paper read before the Municipal and Allied Foreman's Institute. Gives general information on road construction. The author describes an interesting method of calculating the camber of the road.

Report of the New York State Joint Committee on Highways. Gd. Rds. Mag., March, 1908; 3 pp.

An abstract of the report of the State Legislative Committee appointed to investigate and report upon a proper development of the whole system of highway improvement in New York State, to provide for construction and maintenance and to completely revise and codify the present highway law.

Convict Labor in Virginia. Gd. Rds. Mag., March, 1908; 1½ pp.

Contains extract of State law regarding employment of convicts in public road work. An extract from the annual report of the State Highway Commission shows the effects of the law.

Present-Day Road Requirements in Town and Country. Surveyor, Feb. 21, 1908; 5½ pp.

A paper by A. Brown, City Engineer of Nottingham, read before the Royal Sanitary Institute. The paper deals chiefly with the roads constructed in Nottingham, and contains a description of the tar macadam roads constructed there, and also the methods employed in laying dust.

Gravel and Macadam Roads and Their Costs. By G. C. Houston. Mun. Eng. Mag., March, 1908; 3 pp.

Abstract of a paper read before the Indiana Engineering Society. The paper gives details of construction of gravel roads in Indiana and general figures of cost.

Paving in the United States. Mun. Jl. & Eng., March 4, 1908; 12 pp.

Data on street paving were obtained from 450 cities and the information has been tabulated in this article. The tables show the kinds and amounts of pavement constructed in 1907 and in service at that date, together with figures of cost and details of construction. The text gives further details as to construction, relative amounts of various pavements, guarantees, etc.

Pavements and Pavement Fillers. Mun. Jl. & Eng., March 6, 1908; 2 pp.

Letters from the City Engineers of Paducah, Ky., New Bedford, Mass., Holyoke, Mass., and Muskegon, Mich., giving information as to the pavements and the pavement fillers used in those cities.

Roadway Widths and Excavations. By George C. Warren. Mun. Jl. & Eng., March 4, 1908; 2 pp.

Gives arguments favoring narrower roadways, with side and middle packing. Typical illustrations of such construction are given.

Brick Paving in a Number of Cities. Mun. Jl. & Eng., March 4, 1908; 1 p.

A table containing data collected by the American Society of Municipal Improvements. The table gives much information as to details of construction and unit cost of brick pavement in 15 cities.

SEWERS.

Sewerage Purification Works for Berlin-Wilmersdorf, Germany. By W. P. Gerhard. Eng. News, March 19, 1908; 4 pp.

Describes new biological sewage purification plant at the suburb of Wilmersdorf, near Berlin, and gives some results of operation.

A Unique Sewer Cleaner. Mun. Eng. Mag., March, 1908; ½ p.

Illustrates and describes a special "home made" cleaner used in cleaning hard deposit from an 18 in. tile pipe sewer.

Copper Sulphate for Sewage Filters. Mun. Jl. & Eng., March 11, 1908; ½ p.

Briefly describes use of copper sulphate to prevent growth of oscillaria on filter beds at Pawtucket, R. I.

Sewage Purification for the City of New York. By Walter E. Parfitt. Proceedings Brooklyn Engineers' Club, 197 Montague St., Brooklyn, N. Y., January, 1908; $2; 21 pp.

Treats of the need of purification of the sewage of New York City and suggests that this can be done by placing at the outflow end of each sewer a separate purifying system, for the treatment of the sewage by the nascent oxygen process. Designs for a plant of this type are shown.

GARBAGE AND CITY WASTES DISPOSAL.

The Chicago Garbage Reduction Plant. By Emmons J. Alden. Eng. News, March 12, 1908; 2 1-3 pp.

Describes plant of 500 tons capacity for reducing garbage operated for about 14 months by The Chicago Reduction Co. A general statement is also given of the arrangement between the city and the reduction company about handling garbage. A special feature of the plant is the type of digester used which performs three separate functions at one and the same time, that of

Just Published

The Only Publication Explaining in Detail the Operative Systems of American Railways

Economics of Railway Operation

By
M. L. BYERS, C. E
Chief Engineer Maintenance of Way,
Missouri Pacific Railway

The General Objects of the "Economics of Railway Operation" are

(1) **To so outline the operations of each department** as to give to those not familiar with its workings a sufficient insight to enable them readily to acquire further detailed information through their own observations, and through their ability to inquire intelligently in regard to those features which they do not understand.

(2) **To bring into clear relief the underlying principles of economic operation** with a view to the practical usefulness of this information to the employee in securing better results in that portion of the field under his direction; also to give him a clearer general understanding of the science of railroading, and so fit him for further promotion. In order to make the information available to as many as possible, the use of mathematics and technicalities has been avoided to the utmost.

CONTENTS

Part I—Organization.
Part II—Employment, Education and Discipline of Forces.
Part III—Accounts and Accounting.
Part IV—Reports.
Part V — Economic Operation—General—Maintenance of Way and Structures—Machinery Department Operation—Transportation—Freight Traffic Department—Other Departments.
Part VI—Analysis of Operations and Control of Expenses.
Part VII—Betterments.

Buckram, 6x9 ins., 672 Pages, Many Figures, Diagrams and Forms Illustrating the Best Recent Practice.

PRICE, $5.00 NET.

The Engineering News Book Department
220 Broadway, New York

cooking, pressing and drying the garbage without exposure during the entire treatment.

WATER-WORKS AND HYDRAULICS.

Device for Washing Filters. By Wm. B. Fuller. Eng. News, March 12, 1908; 1 p.

Discusses relation of present slow methods of washing filters to rate of filtration, and describes a device invented by H. W. Blaisdell for washing filters without withdrawing water. The writer gives testimony showing by the use of this machine possible rates of 10,000,000 gallons per acre per day as against present rates of 2,500,000 to 3,000,000 gallons per day.

Novelties in Filtration and Their Theory. By A. Kenna. Eng. News, March 26, 1908; 2 2-3 pp.

An interesting general review of certain novelties in filtration having reference particularly to European practice. An interesting article of the "general information" type by a high authority in his field.

Hauling Main Across Narrows in 1906. By J. Causley. Proc. Can. Soc. C. E., Feb. 20, 1908; 11 pp.

An account of the methods and cost of hauling a submerged 12 in. water main across the narrows at Vancouver, Canada, the stream being about 1,200 ft. wide. This paper will appear in Engineering-Contracting.

Continuous Filtration of Bath Water. By Robert J. Angel. Surveyor, March 13, 1908; 5 pp.

Describes the maintenance of the purity of water used in swimming baths by continuous filtration. The purification plant used at Rotherhithe baths, Bermondsey Borough, is described in the article.

High Head Francis Turbines, Centerville Hydro-Electric Power Plant. By James H. Wise. Eng. News, March 19, 1908; 3 1-3 pp.

Describes in detail a hydro-electric power plant operated by a Francis turbine working under a head of 565 ft. Comparisons are drawn between turbines and impulse wheels for high heads. The article is wholly descriptive, but gives a number of very interesting details of a remarkable water power installation.

Development of the Mechanical Filter Plant. Eng. News, March 5, 1908; 1 2-3 pp.

Divides the mechanical filter into its several essential elements and traces the development of each element to its present position. An excellent paper for the engineer who wishes to inform himself briefly on the development and present status of mechanical filtration. The paper was presented originally to the Ohio Engineering Society by Mr. Philip Burgess, Special Assistant Engineer Ohio State Board of Health.

RIVERS, HARBORS AND CANALS.

The Relation of the Southern Appalachian Mountains to Inland Water Navigation. By M. O. Leighton and A. H. Horton. Forest Service Circular, No. 143; 38 pp.

This paper deals with the subject of storing water during flood times, and sending it through the rivers and streams during the periods of low water, thus making many streams that are not used for navigation, navigable during the entire year. Each river is written up separately, and proposed sites of reservoirs shown. Other valuable information as to the various rivers in this region is given.

The Construction of the Base of Baltimore Light, in Chesapeake Bay. By H. Prime Kieffer. Eng. Rec., March 14, 1908; 5 pp.

A description of the trouble in sinking the caisson foundation of this light house, the caisson turning over on its side, and how it was righted. The method of righting it by means of weights attached to a frame built on the caisson, and with derricks was not only original but of interest. The plant used for the work is described, the article being illustrated with photographs and drawings.

New Method of Wharf Building. By H. A. Crafts. Eng. Rec., March 21, 1908; 1-3 p.

Describes a new method of protecting wooden piles, used in San Francisco. A reinforced concrete cylindrical shell 2 ins. thick is cast, and then driven by a pile driver around the wood pile. The space between the pile and the concrete shell is pumped free of mud and water, and filled in with concrete, thus entirely protecting the piles.

A Novel Breakwater for Algoma Harbor, Wis. Eng. Rec., March 21, 1908; 2-3 p.

A description, with plans, of a breakwater made with concrete caissons, on pile foundations, the caisson being filled with riprap and protected by it. The method of putting them in place is described.

Notes on Electric Haulage of Canal Boats. By Lewis B. Stillwell and H. St. Clair Putnam. Proc. Am. I. of E. E., March, 1908; 35 pp.

A paper based upon tests conducted in 1907 on erection of the Lehigh Canal. The paper contains much data applicable to the general problem of electric operation of canals.

Preliminary Report, Inland Waterways Commission. Eng. News, March 5, 1908; 2½ pp.

The report in full of the Inland Waterways Commission's report on a comprehensive plan for the improvement of the river systems of the United States. The report states the problem in detail and recommends that a permanent commission be appointed to study the problem and develop its solution on the general plan that every waterway should be made to serve the public as largely and in as many different ways as possible.

RAILWAYS.

Memphis & State Line Railroad. Ry. Age, Feb. 28, 1908; 6½ pp.

A descriptive article of the route of this railway and the masonry and bridge work done on this line. The bridge work, consisting of concrete, steel and timber, is illustrated by a number of drawings, showing plans and details, many of which are of interest. One of these being a ballasted floor on a double track timber trestle.

Railroad Track Tanks. By H. H. Ross. R. R. Gaz., March 13, 1908; 5 pp.

An article on track tanks for locomotives to take water while in motion. Descriptive of the essential features of this system, showing by text and drawings, the method of supply drainage and operation. Nearly every detail of the construction is shown. A very complete article.

Station Standards; Virginia Railway. R. R. Gaz., March 13, 1908; 4 pp.

Gives description and drawings, showing standard combination freight and passenger station used on new railroad, also water tanks, and masonry for 80 ft. turntable. Other details of the construction of this road are described.

Rebuilding the Northern Pacific in Minnesota. By H. Cole Estep. R. R. Gaz., March 13, 1908; 2½ pp.

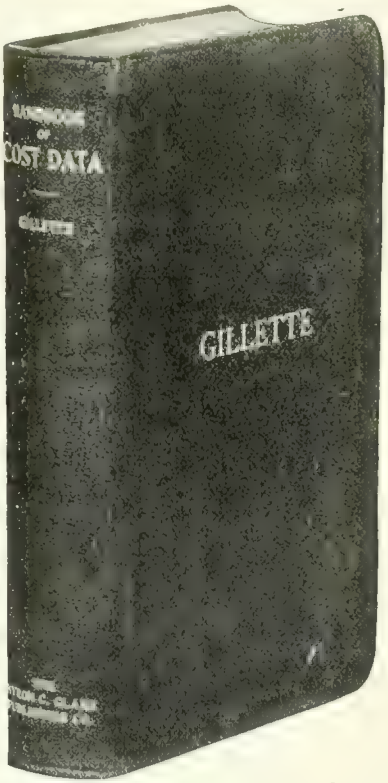
A description of the rebuilding of this line, the special feature of which was a cut-off, where the excavation work was extremely heavy, an embankment 34,000 ft. long being built. Method of taking out a 7,000 ft. cut 45 ft. deep with steam shovels is illustrated.

Curve Superelevation. By M. L. Byers. R. R. Gaz., March 13, 1908; 2¾ pp.

A discussion of formula for curve elevation, based on the assumption that the resultant of the centrifugal force and the weight of the locomotive and car must fall within the middle third of the space between the two rails of the track. Six general conclusions are deducted from the discussion:

Handbook of Cost Data
By HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting"

"Cost Data" has broken all records for the sale of technical books. Over 10,000 copies were sold in less than two years; 1,600 in last three months. The book has over 600 pages of actual costs taken from the private records of engineers and contractors, and so itemized and analyzed as to be of inestimable value to any person who has to do with making bids and estimates or in checking estimates. This covers the whole field of contract work, giving the cost of labor and materials required for every kind of construction from the laying of sod to the building of reinforced concrete sewers. No detail of contract work has been too small to be described and recorded. Wages and prices of material are given in every case, so that proper substitution can be made where conditions differ. It gives also valuable data on methods of construction, thus enabling foreman to handle work in the most economical manner possible.



The general headings are:
- Cost-Keeping, Preparing Estimates, Organization of Forces, etc.
- Cost of Earth Excavation.
- Cost of Rock Excavation, Quarrying and Crushing.
- Cost of Roads, Pavements and Walks.
- Cost of Stone Masonry.
- Cost of Concrete Construction, all kinds.
- Cost of Water-Works.
- Cost of Sewers, Vitrified Conduits and Tile Drains.
- Cost of Piling, Trestling, Timberwork.
- Cost of Erecting Buildings.
- Cost of Steam and Electric Railways.
- Cost of Bridge Erection and Painting.
- Cost of Ry. and Topographic Surveys.
- Cost of Miscellaneous Structures.

24 Page Circular, showing Contents and Sample Pages, will be mailed FREE on request.

THE MYRON CLARK PUBLISHING CO.
355 Dearborn St. Chicago

1. Elevation should admit of locomotive stopping with safety.

2. Curve tables should be used; showing safe maximum speed for given elevation, as well as proper elevation for given speed, for locomotive with the highest center of gravity on the road.

3. All curves should be given elevation that will make them safe for maximum speed of late trains.

4. All curves of 1 deg. or over should be spiraled, and maximum elevation reached on spiral.

5. The ill effect of high center gravity, long wheel base and other unbalancing of locomotives should be kept in mind.

6. As the elevation is usually a compromise, the extent of the variation of the extreme conditions from the compromise should be borne in mind and the track regulated accordingly.

New Bridge Derrick Cars, Chicago, Milwaukee & St. Paul. Ry. Age, March 13, 1908; 2½ pp.

A description and photo-illustration of a derrick car built for bridge erection, with a boom that allows work to be done 80 ft. ahead of the car. The car, A frame and boom are all built of structural steel. The car is 51 ft., while the outrigger is an I beam that is almost as long as the car is wide. With two of these cars, a bridge of considerable span can be erected without false work. Plans of car body and derrick are shown.

Some Instructive and Methodical Ideas as to the Handling of High Pressure Power by Enginemen So as to Render Satisfactory Service to Both the Mechanical and Transportation Departments. By John A. Talty. Proc. Cen. Ry. Club, March, 1908; 4 pp.

A very practical paper on the handling of a locomotive, and economically and safely operating it. Many good suggestions are made in the paper. Contractors would do well to put this article in the hands of their enginemen, as much that is stated would apply to their work, as well as it does to operating locomotives on standard railroads.

Preliminary Report on the Income Account of Railways in the U. S. for Year Ending June 30, 1907. 77 pp.

This pamphlet is issued by the Interstate Commerce Commission. It contains summary of earnings and of operating expenses for the year of all railroads, and comparison in the former years. Then the income for each road in the country is given in tabular form, being given under 12 groups, the grouping being territorial. Distributed by the Commission.

Nineteenth Annual Report on the Statistics of Railways in the U. S. by the Interstate Commission, for the Year Ending June 30, 1906. 750 pp.

This report includes statistics of all kinds according to territorial groups into which the railways are divided. Showing mileage, capital, income, expenses, earnings, classification of railways, accidents and much other valuable data. For distribution by the Commission.

Tonnage Rating of Locomotives. By B. A. Worthington. Proc. Ry. Club of Pittsburg, March, 1908; 42 pp.

A very thorough discussion of the methods of rating tonnage of locomotives. Consideration is given to speed, gradients, carload, engine power and train resistance. Various formulas are given and commented upon, and numerous diagrams are used to illustrate the text. A discussion of members follows the paper.

Reports on Roadway. By Committees of Am. Ry. Eng. & M. of W. Asso. Ry. Age, March 20, 1908; 33 pp.

Reports submitted at the recent convention in Chicago. They include methods of ballasting, forms for reports of rail failures, grade and curve improvement for work

"I would have given $1,000.00 for this book a year ago."—W. H. Burk, Knoxville, Tenn.

"FIELD SYSTEM"

By FRANK B. GILBRETH, M. Am. Soc. M. E.

WHO THE AUTHOR IS.—Frank B. Gilbreth is the contractor who has made the "cost-plus-a-fixed-sum-contract" famous. In order to handle contract work scattered all over North America, Mr. Gilbreth found it necessary to develop a system whereby his foremen would execute work properly, promptly and economically. The code of rules and instructions to his foremen, and the printed forms for their reports, were bound in book form, and this book Mr. Gilbreth called his "Field System." Mr. Gilbreth's contracts have covered the widest possible range. Railways, canals, dams, factories, office buildings, whole industrial towns, are among the works that he has executed.

WHY ENGINEERS SHOULD STUDY "FIELD SYSTEM."—Every engineer should know how to manage men, for, whether he confines himself to purely professional work or enters into business of executing construction work, his ambition should be to direct the men under him in a manner that will secure the greatest possible efficiency. A revolution in the art of managing men is now in progress. Direct personal supervision was once deemed essential. To-day, however, "system" is fast supplanting personal supervision. By "system" we mean printed or written directions for employes to follow, and daily reports that show what the employes have done. System of this sort has recently been extended to the field survey work of the U. S. Geological Survey. While Gilbreth's "Field System" is not a system for the management of surveys, for example, it is rich in suggestions that can be applied in the management of any kind of field work, whether employes are engaged in surveying or in construction. Its rules and methods are applicable to office work, in so far as the principles involved are concerned. The book, in brief, is a treatise on the science of managing men by system. No engineer who aims to be more than a subordinate can afford not to have this treatise, written by a man who is an acknowledged adept in managing men.

Hundreds of engineers have gone into the contracting business during the past few years, and there is room for thousands more. But if they are to succeed in any great measure, it must be by the intelligent application of system and cost analysis. Gilbreth's "Field System" does not cover the whole field, nor was it written to cover it, but it does cover a very important part of the field, and a part upon which practically nothing has ever been written.

WHY CONTRACTORS SHOULD HAVE "FIELD SYSTEM."—Mr. Gilbreth has done in contracting what Mr. W. L. Douglas and Mr. Marshall Field have done in the mercantile field. He has taken a class of work involving endless detail, and has reduced the handling of these details to a system by virtue of which economy in construction and celerity in performance are secured, regardless of place or men. Every one has heard the expression, "one-shovel contractor," meaning a contractor capable of managing only one steam shovel at a time. The "one-shovel contractor" is the antithesis of the contractor having a system. The "one-shovel contractor" receives daily reports, it is true, but his reporters are his two eyes. The "one-shovel contractor" has a code of instructions for his men, it is true, but his ready tongue is the only leaf of a code bound between the cover of two jaws. The day of the "one-shovel contractor" is not yet gone entirely, but it will pass rapidly away. Every contractor should have a field system of his own, embodying his own experiences and covering his own necessities, but in the developing of such a field system no contractor can afford not to study the work of Mr. Gilbreth.

COPIES OF "FIELD SYSTEM" STOLEN.—When it became generally known that Mr. Gilbreth had supplied his foreman and superintendents with printed instructions, copies of the book were bribed from his employes, and photographed page by page, from cover to cover. Other copies were "lost," and thus made way with entirely. Huge salaries were used to hire away Mr. Gilbreth's superintendents, for the purpose of getting not only their trained services, but for their knowledge of the contents of the "Field System."

MAKING THE BOOK PUBLIC.—Mr. Gilbreth's action in making public his "Field System" in its entirety is without precedent in the world of business. It is an act that puts contracting on the high professional level of civil engineering. The civil engineer discloses his method of designing a structure, his purpose being to assist other engineers in doing as well. In the interest of scientific advancement the engineer places on record what he has found to be economic or effective. In the same spirit—we may call it the modern American spirit—Mr Gilbreth has permitted publication of his private code of instructions to his men—his "Field System." He believes that contractors, and, indeed, all professional business men, will become far more efficient as managers of men if such systems as this are disclosed. He believes that in the general rise of efficiency that will occur all those engaged in business will share. He believes that those who are best fitted to be leaders will remain leaders. Character, experience and ability will have the same relative weight as ever. In these beliefs every broad-minded man ought to concur.

China is a nation that worships "trade secrets." It is a nation of industrial mutes. Their arts and their manufactures are taught by father to son, and zealously guarded. There has been no pyramiding of improvements upon one original invention as a base. The Chinese do not lack inventive ability. They are merely cursed by the curse of secretiveness. Their industries are plastered with signs of "No admittance," and are mummified in consequence. In striking contrast with the Chinese method is the American method. Our doctors, or engineers and our men of science generally have never concealed their discoveries or their improvements. Latterly our business men have shown a recognition of the truth of the general proposition that it pays the individual to share his discoveries with the rest of his fellows. Such generosity, in the final analysis, is simply an enlightened selfishness. The publishers of Gilbreth's "Field System" urgently request other contractors and business men to come forward with their systems, and put them permanently on record. Let business men generally adopt the altruistic policy that actuates professional men, and in its prosperity America will soon rise as far above its present level as it now stands above the level of the Chinese Empire.

PRICE OF THE "FIELD SYSTEM."—The book has 200 pages, bound in leather, and its price is $3 net, postpaid. Order now, before the edition is exhausted.

THE MYRON C. CLARK PUBLISHING CO.

355 Dearborn Street, Chicago

within of cities, and many other features of track construction and maintenance.

Improvement of the Brighton Beach Line, Brooklyn Heights R. R. Co. By Harry B. Snell. Proceedings Brooklyn Engineers' Club, 197 Montague St., Brooklyn, N. Y., January, 1908, $2; 16 pp.

This work described in this paper was done in connection with the elimination of grade crossings in Brooklyn. Part of the line of the above electric railroad had to be depressed and part had to be elevated upon an earth embankment. The methods used by the contractors in the work are described in the paper. Numerous illustrations are given, showing different phases of the work, and plant employed.

Some Early American Railroad Engineers. By O. F. Nichols. Proceedings Brooklyn Engineers' Club, 197 Montague St., Brooklyn, N. Y., January, 1908; $2; 37 pp.

An interesting historical paper treating of the engineers connected with the early railroads of this country. Interwoven with the biographies of the engineers is much interesting information regarding the construction and equipment of the first railroads of this country. The paper is illustrated with numerous portraits and reproductions of drawings of the engines used when railroading was new.

Constructing a Railway Embankment by the Hydraulic Method. By Geo. H. Moore. Eng. News, March 12, 1908; ¾ p.

Brief description of hydraulic plant constructed to make hydraulic fill of some 750,000 cu. yds. on new line of Chicago, Milwaukee & St. Paul Ry. through Cascade Mountains.

The Cheapest Railway in the World. Eng. News, March 5, 1908; 1-6 p.

Gives items of cost of a railway 82 miles long constructed in Texas at a total cost of $4,900 per mile.

The Future Policy of Railways With Reference to Tie Supply. Eng. News, March 26, 1908; 2 pp.

Abstract of report of Committee on Ties, American Railway Engineering and Maintenance of Way Association. The report discusses methods for the more economical cutting of ties, purchase and management of forest lands, planting trees for tie purposes, with some figures on costs and the importation of ties from other countries.

Railway Yards, Warehouses and Freight Handling Machinery. Eng. News, March 26, 1908; 4 pp.

Abstract of report of Committee on Yards and Terminals, Railway Engineering and Maintenance of Way Association. A very thorough and practical discussion of the subjects treated.

The Strength and Endurance of Steel Rails. By James E. Howard. R. R. Gaz., March 27, 1908; 6 pp.

Gives the result of tests and various experiments made at the Watertown Arsenal. Illustrated with numerous halftone cuts. This is one of the most valuable contributions to literature on the subject of rails that has recently been published. This paper was read before the Am. Ry. Eng. and M. of W. Asso. The tests begin with the metal in ingots and go through various stages of the metal until in the completed rail. Various tests as to strength, toughness, durability and other features of steel rails have been made.

The Metal Tie. By Dr. I. A. Haarmann. R. R. Gaz., March 20, 1908; to appear serially.

From an address delivered at the meeting of the "Verein der deutschen Eisenhuttenlente." Reviews the use of the tie, showing the wear on it, both with a chair and plate, and gives the history of the metal tie, illustrating various designs that have been used and are now in use.

ELECTRIC RAILWAYS.

Track Construction in Streets for Interurban Service. By Thomas B. McMath. Mun. Eng. Mag., March, 1908; 2 pp.

Extracts from a paper read before the Indiana Engineering Society. The author describes the selection of a proper rail section and preparation of the roadbed.

TUNNELS AND SUBWAYS.

Compressed Air in Modern Engineering. By Wm Andrews Proceedings Brooklyn Engineers' .Club, 197 Montague St., Brooklyn, N. Y., January, 1908; $2; 12 pp.

Describes several of the large plants used in tunnel work in New York City. Among the plants described are those of Pearson & Co., The O'Rourke Engineering Construction Co., and the Degnon Contracting Co.

Shaft Timbering Transvaal. By Eustace M. Weston. Eng. & Min. Jl., March 14, 1908; 2 pp.

Describes methods of framing and setting timbers in shaft sinking on the road. Drawings are shown of timbers composing a shaft set and the joints used on these timbers.

BRIDGES AND BUILDINGS.

A Study of Roof Trusses. By N. Clifford Ricker. Engr.-Contr., March 11, 1908; 2 2-3 pp

Outlines series of investigations made on roof trusses at the University of Illinois, gives new and simple formula for weight of trusses and diagrams for economic panel length, truss spacing, purlins per panel, etc.

Report of the Royal Commission on the Cause of the Collapse of the Quebec Bridge. Eng Rec., March 14, 1908, 22 pp

This commission consisted of Henry Holgate, J. G. G. Kerry and John Galbraith. In the report proper the failure of the bridge is attributed to the defective design of the lower cords in the anchor arm near the main pier. The workmanship and the quality of the steel were approved by the commission. There are a number of appendices giving the testimony before the commission, and considering the effect of the specifications, the organization of the staffs maintained by the different corporations, the development of the plans, etc., the transportation and erection, and the collapse of the structure. It seems from the report, that the Quebec Bridge & Railway Co. did not appoint an experienced bridge engineer to the position of chief engineer.

Report of the Royal Commission of Inquiry on the Collapse of the Quebec Bridge. Eng. News, March 19, 1908; 8 pp.

This is a lengthy abstract of the voluminous official report of the Commission dated Feb. 20. The abstract is divided into: Objects of the Inquiry; History of the Bridge Project; Working Organization and Staff; Development of Specifications, General Design and Details; Material, Shopwork and Inspection; Problems of Transportation and Erection; Progress of the Erection, Difficulties that Arose and the Events Prior to the Collapse; Conclusions as to the Events Causing the Collapse.

Substructure of Piscataquis Bridge, and Analysis of Concrete Work. By G. A. Hersey. Proc. Am. Soc. C. E., March, 1908; 6 pp.

A description of this steel railroad bridge on concrete piers and abutments is given, the substructure being built by means of a cableway. An analysis of the amount of cement used in the concrete is made.

Erection of The Bellows Falls Arch Bridge. By L. D. Rights. Proc. Am. Soc. C. E., March, 1908; 8 pp.

A description of this steel arch bridge with suspended floor, is given both as to the design of the bridge and the method of erecting. Illustrated with drawings. Ab-

Cements, Mortars and Concretes

—Their Physical Properties

An up-to-date Compendium of Reliable Tests of Cements, Mortars and Concretes

By

MYRON S. FALK, Ph. D.

Instructor in Civil Engineering, Columbia University.

This book contains a very complete report of the results of tests made during the past fifteen years, and gives these results in tables and diagrams classified according to subjects. This is a reference book that should be in the library of every civil engineer. The contents include chapters on Chemical Properties of Cement, Physical Tests of Cement, General Physical Properties, Elastic Properties in General, Tensile Properties, Compressive Properties, Flexural Properties, Report on Uniform Tests of Cement by the Special Committee of the American Society of Civil Engineers, and Constitution of Cement.

Cloth, 6x9 inches; 184 pages; illustrated; price $2.50 net, postpaid.

Practical Cement Testing

By

W. PURVES TAYLOR, M. S. C. E.

Engineer in Charge of Philadelphia Municipal Testing Laboratories.

This is the first practical and exhaustive treatise on this important subject. It has already been adopted as a text-book by the University of Pennsylvania and other technical schools. Each chapter contains a minute description of the methods followed in the author's laboratory and many valuable suggestions as to the "how" and "why" of cement testing. The observations on the interpretation of results, one of the most difficult tasks of the novice, are especially pertinent and are expressed in a fair and conservative manner.

The book is so complete that it can be put in the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. The wealth of photographs and line cuts furnish the pictorial examples of how to conduct cement tests, and the 300 pages of texts are so explicit that even the most inexperienced man can soon learn the art of cement testing. Yet the book has not a superfluous paragraph. The list of chapters includes: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13) Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement than Portland, (16) Specifications (The Author's, Am. Soc. C. E.; Am. Soc. Test, Mtls.; Soc. Chem. Indust.; Corps Eng. U. S. A.; British Standard, Can. Soc. C. E.).

Cloth, 6x9 inches; 330 pages; 142 illustrations; 58 tables; $3.00 net, postpaid.

The Myron C. Clark Publishing Company

355 Dearborn St., Chicago

stracts of this paper will be published in Engineering-Contracting

Waterproofing Ballasted Bridge Floors at Schenectady, N. Y. Eng Rec., March 28, 1908; 3 pp.

Illustrates and describes the method of waterproofing the solid concrete bridge floors of steel bridges, by the use of burlap and asphalt. The work has proven successful.

CONCRETE AND REINFORCED CONCRETE.

Results of Tests of Cement Drain Tiles. Engr.-Contr., March 25, 1908; 2 pp.

Describes series of tests of 4 to 12 in. diameter cement drain tile made at the Iowa State College. Data given are among the very few that have been published and are, therefore, of unusual interest.

Methods and Plant Used in Placing Concrete and Masonry for Brooklyn Anchorage for Manhattan Bridge. By Gustave Kaufman. Engr.-Contr., March 18, 1908; 3 1-3 pp.

The anchorage contained some 92,000 cu. yds. of concrete and 10,000 cu. yds. of granite masonry and required 42,000 cu. yds. of excavation. This article describes at length the plant installed for doing the work and gives reasons governing the selections made. The plant was novel for its operation by electric power throughout and some unique data are given of power required to operate centrifugal pumps, power pumps, belt conveyors, bucket elevators and derricks. The article is valuable for these data.

Methods and Cost of Constructing a Cement Storage House of Separately Molded Members. Engr.-Contr., March 18, 1908; 1 p.

Columns, girders and roof slabs were molded separately. Forms for the different members are illustrated and costs of molding are given in detail.

Special Methods of Tearing Out Old Concrete Roadbed for Cable Railway and Rebuilding for Electric Railway. Engr.-Contr., March 11, 1908; ¾ p.

Describes use of derrick car for tearing out old cable yokes and concrete and traveling crushing plant for recrushing concrete for ballast for new line. The methods adopted resulted in material reduction in cost.

Method and Cost of Constructing and Erecting Reinforced Concrete Poles. Engr.-Contr., March 11, 1908; 1 p.

Describes the method of constructing reinforced concrete poles for a stretch of telephone line near Richmond, Md. The cost of typical poles is given in detail, and there is also a record of comparative costs of reinforced concrete and of cedar poles.

Cost of Constructing Street Railway Track With Rubble Concrete Base at Ft. Wayne, Ind. Engr.-Contr., March 11, 1908; 2-3 p.

Gives methods of constructing foundation for street railway track, using cobble stones from old pavement. Itemized cost of the work is given.

Necessity of Continuity in the Steel Reinforcement of Concrete Structures. By E. P. Goodrich. Engr.-Contr., March 4, 1908; 2½ pp.

The author discusses the various sources and kinds of stresses in concrete structures in their bearing on the necessity of continuity of reinforcement. He concludes that logic seems to dictate that all structures which are at all monolithic in character, thus having members continuous over supports or through floor levels, should have their reinforcement so designed and placed as to make them act under all load conditions as their original monolithic nature would make them start to act.

Cost of Highway Bridges and Culverts in Greene County, Ia. Engr.-Contr., March 4, 1908; 2-3 p.

Describes construction of two slab girder

Ready April 4

CONCRETE CONSTRUCTION
METHODS AND COST

By
Halbert P. Gillette
M. Am. Soc. C. E., M. Inst M. E.,
Managing Editor, Engineering-Contracting
and
Charles S. Hill, C. E.,
Associate Editor, Engineering-Contracting

THIS book handles the subject of concrete construction entirely from the view-point of the ***builder*** of concrete structures. The testing of cement, the physical properties of cements and concrete, and the design of concrete structures are not considered. The aim of the authors has been to eliminate all matter not germane to the constructing end of their subject. By doing this it has been possible to crowd a vast amount of detailed information on methods and cost of concrete construction into a volume of moderate size. The book is a treatise on the ***methods and cost*** of building in ***concrete.***

WHILE concrete design is not considered, no designer of concrete can be a really good designer without having a profound knowledge of costs and of practical methods of construction. This book will be of interest therefore to every engineer and architect who is engaged in designing concrete structures. It should be of particular assistance, however, to the contractor or engineer engaged in the actual work of making and placing concrete.

THE methods given are practical methods and they are so given that the practical man can use them. The costs given are actual costs, itemized, analyzed and reduced to units. Costs of material, costs of transporting, costs of mixing, costs of placing, costs of tamping, costs of finishing, costs of forms, costs of bending and placing reinforcement, costs of waterproofing, costs of superintendence, costs of plant, interest charges, depreciation charges are all given, and to make these costs useful, the conditions and the methods of doing the work are stated in each case.

Cloth, 6 x 9 inches, 700 pages, 320 illustrations, $5 net, postpaid.

The Myron C. Clark Publishing Co.
355 Dearborn St., Chicago, Ill.

highway bridges with concrete abutments and gives itemized cost of labor and materials for both.

Standard Tests for Concrete Building Blocks. Engr.-Contr., March 4, 1908; 2-3 p.

Gives tests for building blocks recommended by Committee of National Cement Users' Association.

Economical Design of Reinforced Concrete Beams. By Elie Caunes. Eng. Rec., March 7, 1908; ¾ p.

The designing of concrete beams to carry the given load at the minimum cost is considered. For this purpose diagrams are given to conform to the local conditions in New York City, on the assumption of the cost of a beam depending on the relative combination of materials, that is, upon the percentage of steel. Of interest to designers of reinforced concrete structures.

A Three Hinge Reinforced Concrete Skew Arch Bridge in Denver, Col. Eng. Rec., March 21, 1908; 3½ pp.

On account of the erection of this three hinge bridge with a description of the design, illustrated with a number of the detailed drawings, showing reinforcement, shoe and rocker plates.

Reinforced Concrete in the Building of a Cement Plant. Can. Engr., March 6, 1908; 2 pp.

The article describes the construction of the reinforced concrete portion of the Longue Pointe, Canada, plant of the Vulcan Portland Cement Co. An interesting feature of the construction of the stock house was that the column and beam reinforcement and the ties connecting the columns on opposite sides of the bins were all of structural steel shapes with riveted connections.

A Practical System of Reinforcing Concrete. By H. F. Porter. Can. Engr., March 6, 1908; 2½ pp.

The system described in this paper is based upon the use of plain reinforcing bars. The paper was read before the Engineering Society of Faculty of Applied Science.

Comparative Costs of Gravity and Reinforced Concrete Retaining Walls. Eng. News, March 26, 1908; ½ p.

Mr. Frank A. Bone presents several comparative designs of gravity and reinforced concrete retaining walls and gives relative costs.

Peculiar Concrete and Steel Bridge in France. Eng. News, March 26, 1908; ¾ p.

Describes briefly and illustrates a three-hinged arch of 286 ft. span in which all members are of structural steel embedded in concrete. A very full analysis of the stresses in this structure and of the method of computing them is given in "Annales du Ponts et Chaussees," Part 4, 1907.

Reinforced Concrete Intercepting and Outfall Sewer. By Wm. G. Taylor. Eng. News, March 26, 1908; 3 pp.

An interesting description of an unusual piece of reinforced concrete sewer design and construction with some general figures on cost. In one case the sewer conduct is enclosed in concrete retaining wall, and in several other cases three conduits are grouped in one concrete structure. Methods of work are described, and a type of expensive joint worth study is shown.

Hoist for Feeding Material to Concrete Mixers. Eng. News, March 5, 1908; 1 p.

Describes a hoist with automatic dump bucket suitable for handling concrete materials or concrete in building work or construction of any kind where considerable vertical hoist is necessary. Some general figures of capacity and cost of operation are given.

Costs on a Reinforced Concrete Factory Building. Eng. News, March 5, 1908; ¼ p.

Gives partially analyzed costs of concrete work in a reinforced concrete factory building built in Canada. The figures are reprinted from an article in the Journal of the University of Toronto Engineering Society.

Adjustable and Portable Forms for Concrete Building Construction. Eng. News, March 5, 1908; ½ p.

Illustrates column and slab and girder forms for building work. The forms are adjustable so that they can be transferred from story to story and from building to building. They are controlled by patents.

Defective Foundations, Mt. Royal Water Works Pumping Station, Baltimore, Md. By Alfred M. Quick. Eng. News, March 12, 1908; 4 pp.

Describes failure of heavy concrete foundations with outline of investigations made to determine cause of failure. Rotten concrete appears to have been chief cause; poor concrete due to use of poor materials. Outline of method followed in repairing foundations is also given.

Reinforced Concrete Sea Defenses. By H. Huisman. Conc. & Cons. Eng., March, 1908; 7 pp.

Shows reinforced concrete slope paving used by the author in a number of works in Holland, and illustrates and describes method of construction in considerable detail. An interesting account of a use for concrete with which American engineers are not familiar from practice.

Reinforcement for Concrete. By Emile G. Perrot. Ins. Eng., March, 1908; 7 pp.

An interesting presentation of the advantages claimed for unit reinforcing frames for concrete building work.

Reinforced Concrete in Reservoir Construction. By E. R. Matthews. Conc. & Cons. Eng., March, 1908; 10 pp.

This article is useful as a record of British practice in the construction of covered reservoirs in concrete and for the comparisons of cost which it gives between concrete and other masonry for such reservoirs. In general, the author states, reinforced concrete is some 15 per cent. cheaper than mass concrete or brickwork. Drawings and descriptions are given of a number of reinforced concrete reservoirs with a general discussion of the materials and methods of work for securing the best results in this class of construction.

Reinforced Concrete Leading Jetty, Manchester Ship Canal. By W. H. Hunter. Conc. & Cons. Eng., March, 1908; 6 pp.

Gives some interesting illustrations of hollow reinforced concrete caissons sunk and anchored so as to interlock and form a leading jetty at the Irlam Lock of the Manchester Ship Canal. The caissons, which weighed from 73 to 107 tons in air, were molded on shore and handled and lowered into place by a powerful crane.

Use of Concrete in Mines. By W. R. Crane. Conc. & Cons. Eng., March, 1908; 6 pp.

Describes briefly a number of mine shaft linings of concrete, giving general figures of cost; also shows examples of concrete shaft stringer construction.

Some Reinforced Concrete Bridges in Italy. Conc. & Cons. Eng., March, 1908; 7 pp.

A series of half-tone illustrations of a number of reinforced concrete bridges of notable character recently constructed by Italian engineers.

The Reinforced Concrete Reservoirs and Aqueduct of Mexico City. By James D. Schuyler. Eng. Rec., March 28, 1908; 4 1-3 pp.

Describes the design of four reinforced concrete circular reservoirs covered with a concrete roof. Also the method of construction. A revolving steel bridge was erected to place the concrete in the forms. The forms for the roof were not held up by timber, but were suspended from the tops of columns by a series of steel I beams, of standard size and lengths. These would

Rock Excavation
Methods and Cost
By
HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting."

One superintendent who purchased this book about a year ago writes us that he has cut the cost of his drilling and blasting practically in two since he received the book and applied the methods given by Mr. Gillette. We doubt whether such a statement has ever before been truthfully made of any books except those written by Mr. Gillette. His books are practical books for practical men, and the key-note throughout is economy—how to save money on the work and how to increase the output.

"Rock Excavation" has chapters describing:

Rocks and Their Properties.
Methods and Cost of Hand Drilling.
Machine Drills and Their Use.
Steam and Compressed Air Plants.
The Cost of Machine Drilling.
Cost of Diamond Drilling.
Explosives.
Charging and Firing.
Methods of Blasting.
Cost of Loading and Transporting Rock.
Quarrying Stone.
Open Cut Excavation.
Methods and Costs on the Chicago Drainage Canal.
Cost of Trenches and Subways.
Subaqueous Excavation.
Cost of Railway Tunnels.
Cost of Drifting, Shaft Sinking and Stoping.

Cloth, 5¼x7 in., 384 pages, 56 figures and illustrations; $3 net postpaid.

Earthwork
And Its Cost
By
HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting."

A book that should be in the hands of every man who is in charge of "moving dirt," whether with pick and shovel, plow and scraper, steam shovel and dredge, or any other tool for digging and conveying earth. The contents include:

The Art of Cost Estimating.
Earth Shrinkage.
Earth Classification.
Cost of Loosening and Shoveling.
Cost of Dumping, Spreading, Rolling.
Cost of Wheelbarrows and Carts.
Cost by Wagons.
Cost by Buck and Drag Scrapers.
Cost by Wheel Scrapers
Cost by the Elevating Grader.
Cost by Steam Shovels.
Cost by Cars
How to Handle a Steam Shovel Plant.
Summary and Table of Costs.
Cost of Trenching and Pipe Laying.
The Cost of Hydraulic Excavation.
Cost of Dredging.
Miscellaneous Cost Data.
Earth and Earth Structures.
Rapid Field and Office Survey Work.
Overhaul Calculation.
A Small "Home-Made" Dipper Dredge or Steam Shovel.
Detailed Description and Drawings.
Cost of Making the Dredge.
Cost of Operating.

Cloth, 5x7½ in., 260 pages, 50 figures and illustrations; $2.00 net postpaid.

The Myron C. Clark Publishing Co.
335 Dearborn St., CHICAGO

ave a greater salvage than the timber. By this method the concrete beams were not made monolithic, but a series of tests made showed that strength in the girders was not sacrificed. A reinforced concrete conduit or aqueduct is also described.

MATERIALS OF CONSTRUCTION.

The Analysis and Grading of Creosotes. By Arthur L. Dean and Ernest Bateman. Forest Service Circular, No. 112; 44 pp.

A very comprehensive paper on creosotes, giving much valuable information on the subject. The results shown are practical, and those interested in the preservation of timber will find this circular of much interest.

Portland Cement Mortars and Their Constituent Materials. By Richard L. Humphrey and William Jordan, Jr. Bulletin No. 331 of U. S. Geological Survey.

This bulletin contains 130 pages, being the recorded results of 25,000 tests made by the geological department at the laboratories at Forest Park, St. Louis, during the years 1905-7. The tests covered individual brands of Portland cement and also a typical cement, made by mixing a number of brands together. Various tests were also made with sands, gravel and limestone screenings and Portland cement made into mortar. Many tables and diagrams illustrating the tests are given. A valuable bulletin.

SURVEYING AND DRAFTING.

Laying Out Curved Boundaries for City Lots. Eng. News, March 12, 1908; 1-6 p.

Gives table of deflection angles of curves and directions for instrumental work where only street corners and roads are known.

Some Useful Tools for Surveyors Working Alone. By Thalion Blake. Eng. News, March 19, 1908; ½ p.

Illustrates and describes special marking pins, devices for holding surveyors' rods and boundary moments for holding rods. A useful article to surveyors.

Astronomical Bearings by Sun Observations. By D. D. James. Can. Engr., March 6, 1908; 2 pp.

Describes a method for securing bearings, and the operations and formulas for calculating agimuth.

EARTH AND ROCK EXCAVATION.

Methods of Grubbing Stumps and Trees. Engr.-Contr., March 25, 1908; 3 pp.

This article gives 4 methods of grubbing stumps: (1) By hand; (2) by boring; (3) by blasting; (4) by stump pullers. Each method is described at some length and details of the work commented upon. The use of the stump pullers is fully explained, and illustrations show how they are operated.

The Cost of Excavating Trenches by Hand for Electrical Conduits in Baltimore, Md. Engr.-Contr., March 11, 1908; 1 p.

A record, extending over nine years, of trench excavation, giving the yardage moved, the total cost, and the cost per cubic yard. Also the size of ditches and methods used, with the wages paid each year. The local conditions surrounding the work are described.

The Cost of Digging Some 600 Trolley Pole Holes. Engr.-Contr., March 4, 1908; 1¾ pp.

Giving the method of cost of digging these holes, with comments as to why the costs varied somewhat. Some of the work was for single track, some for double track, while some was span wire construction, and also bracket construction.

Methods of Thawing Explosives. Engr.-Contr., March 11, 1908; 1½ pp.

A paper on this subject by P. N. Dennison, of the Du Pont Co., read before the Ohio State Stone Club. The danger of thawing dynamite is pointed out, and a number of suggestions are made as to safe

The world's authority on this great subject.
The most expensive book ever issued and sold for $5.00.

Concrete and Reinforced Concrete Construction

By HOMER A. REID, Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; $5 net, postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete, on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter — material never previously published. This work is complete, up-to-date and original. No other book on concrete contains one-tenth so much of the very latest data on tests, theory and practice.

In a two-column review of this book, "Manufacturers" Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

Write for 16-page Table of Contents.

THE MYRON C. CLARK PUBLISHING CO.
(NOT INCORPORATED)
355 Dearborn St. **CHICAGO**

methods of handling and thawing frozen dynamite.

Comparison of the Cost of Wheel and Drag Scraper Excavation on a Job in Mississippi. Engr.-Contr., March 4, 1908; ¾ p.

Gives a record of doing excavation for enlarging a logging pond by these two methods. The wheel scraper work proved the cheaper.

Cost of Shaft Sinking at Goldfield. Engr.-Contr., March 4, 1908; ½ p.

Gives the cost of sinking a 100 ft. shaft showing the total cost of all items, and the cost per lin. ft. and per cu. yd. for each item. This, we believe, is the first record published of the cost of shaft sinking in Goldfield.

Machine vs. Hand Drilling in Sinking Shafts. Engr.-Contr., March 18, 1908; 2-3 p.

Compares the two methods of sinking, showing the superior points of each as practiced on the Rand in South Africa. With plenty of cheap Chinese labor, the handwork is cheapest, but greater progress is made by machines.

Methods and Cost of Sinking a Shaft on the Rand With Some Good Suggestions on Drilling. By Eustace M. Weston. Engr.-Contr., March 18, 1908; 2 2-3 pp.

An article telling much that is of value. Gives a form to be used as a log of shaft sinking with machines, and the cost per lin. ft. of sinking 2 shafts. Numerous suggestions as to drilling and other details of the work are made.

Data on the Steam Shovel and Grader Work at the Belle Fourche Dam. Engr.-Contr., March 18, 1908; 1-3 p.

Some notes as to methods and cost of earth excavation and the making of the embankment at this dam, being built by contract for the Reclamation Service. The contractors having gone into bankruptcy, the contract has been suspended.

The Cost of Hydraulic Dredging on the Mississippi River. By Lieut.-Col. Clinton B. Sears. Eng. Rec., March 21, 1908; 1 p.

Gives the cost of operating and maintaining 6 dredges on this river for from 4 to 7 years, with comments on the amount of work done in a season. These data will be published in Engineering-Contracting.

The Fruhling System of Suction Dredging. By John Reid. Eng. News, March 5, 1908, 2 2-3 pp.

Explains the principle of the suction or hydraulic dredge devised by Mr. Otto Fruhling, in which the material is mechanically forced into the head of the suction pipe and then mixed with water and drawn through the pumps. As high as 90 per cent. solid matter is pumped and secured. The German Government "Dredge VII" is described and comparisons of work done are made with a number of American hydraulic dredges. An excellent description of a notable dredging machine.

Recent Developments in Pneumatic Foundations for Buildings. By D. A. Usina. Proc. Am. Soc. C. E., March, 1908; 10 pp.

A review of the methods of sinking pneumatic foundations of buildings, and describing caissons previously used. There are described the features of improvements made in caissons that have both cheapened the cost of this style of construction and also strengthened it.

MISCELLANEOUS.

United States Reclamation Service General Specifications for Telephone Systems. Engr.-Contr., March 4, 1908; 2 pp.

The Reclamation Service, which is building a number of telephone lines, has prepared these specifications for the work being done.

Loose Leaf Binders. By J. H. Haertter. Ms. & Mls., March, 1908; 5 pp.

Describes the method of keeping record of work done and cost of it at the Mountain Top Coal Co.'s Mines, by means of separate sheets of paper, that are then placed in loose leaf binders. In this way the separate reports, and the daily report cards become a part of the complete record without the labor of copying them. Various summaries are made and filed in the same manner.

Pile Driver for Long Piles. Ry. & Eng. Rev., March 14, 1908; 1 p.

A floating steam pile driver for driving piles 94 ft. long, and to drive the piles from 100 to 125 ft. below water, is described and illustrated with drawings. Also the arrangement for cutting the piles off under water. This machine was used for pile driving on the Raritan River, N. J.

The Classification of Industrial Enterprises. By Wm. D. Ennis. Stevens Institute Indicator, January, 1908; 15 pp.

A discussion of the classification of various manufacturing plants, considering the relation of plant cost to value of annual outputs, showing the underlying principal of "first cost," which is applicable to a man's work as well as to a machine. An instructive paper.

Review of Forestry Experiments by American Railways. Ry. Age, March 20, 1908; 3½ pp.

A review of the work done in renewing our forests by the various railroad companies, and numerous valuable suggestions as to forest work, to obtain economical results, with some comments on the kind of trees to plant for timbers to be used for railroad purposes.

Forest Planting on the Northern Prairies. By James M. Fetherolf. Forest Service Circular, No. 145; 28 pp.

A pamphlet showing the value of forests, and giving suggestions as to planting, for protection of farmsteads, and for commercial purposes. Recommendation is made as to the kinds of trees to plant, the method of planting, and the caring for them during growth.

Public Baths and Wash Houses. By T. W. Aldwinckle. Surveyor, March 6, 1908; 7½ pp.

A paper read before the Metropolitan District Meeting of the Association of Municipal and County Engineers, London, England. The paper treats of the design and construction of public baths, particular reference being made to the St. Pancras baths, which were designed by the author. Ground first floor plans of these baths are shown.

The Municipal Ownership of Public Utilities vs. Private Enterprise. Con. Engr., March 6, 1908; 2½ pp.

Extracts from the presidential address of W. McLea Walbank before the Canadian Society of Civil Engineers, in which several of the fallacies of municipal ownership are pointed out.

Labor Cost of Laying Vitrified Clay Electric Conduit. By Dewitt C. Webb. Eng. News, March 12, 1908; 1-3 p.

Gives labor costs of laying some 181,500 duct feet of vitrified clay conduit by day labor at the U. S. Navy Yard, League Island, Philadelphia, Pa. The average labor cost per duct foot was 4 cents.

Construction of Combined Smokestack and Water Tank. By H. Stoffels. Eng. News, March 12, 1908; 1 p.

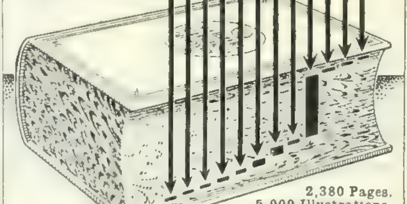
The tank surrounds the stack at about mid height and is supported by the tank. Sketches of construction staging are shown. The points of chief interest are the analyses of the stresses in both tank and stack; the article is of value for these analyses.

Handling Heavy Armor Plate for a Bank Vault. Eng. News, March 5, 1908; ¾ p.

Describes rocker frame and tackle employed in unloading 6 to 29-ton plates from trucks and swinging them over and lowering them through an opening in the sidewalk over the building basement. The device worked with perfect success and is worth noting by building contractors.

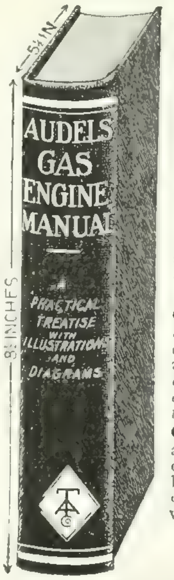
Monongahela Bank Building, Pittsburgh, Pa.
DEAR SIR: I beg to announce that an addition to my book of Tables (a useful collection of data for structural designers' use) now in its second edition, I have issued a book entitled "CONCRETE." This contains 444 pages of information on plain and reinforced concrete and related subjects. Sound engineering and plain rational theory are set forth in this book in a way not approached in any other work. If you are in any way interested in concrete design or construction, you will want this book. I am publishing these two books and have them for sale. The price of the book of Tables is $2.50, or $2.00 to clubs of 5. The price of Concrete is $2 50, net.
Yours very truly,
EDWARD GODFREY.

MANY BOOKS IN ONE
WEBSTER'S INTERNATIONAL DICTIONARY
Do you know that the INTERNATIONAL answers with final authority ALL KINDS of questions in Language, The Trades, Arts and Sciences, Geography, Biography, Etc.? Note Plan of Contents as follows:
Colored Plates, Flags, State Seals, Etc.
Brief History the English Language
Guide to Pronunciation
Scholarly Vocabulary of English
Dictionary of Fiction
Gazetteer of the World
Biographical Dictionary
Scripture Proper Names
Greek and Latin "
English Christian "
Foreign Words
Abbreviations



2,380 Pages.
5,000 Illustrations.
25,000 Added Words.
Should You Not Own Such a Book?
WEBSTER'S COLLEGIATE DICTIONARY. Largest of our abridgments. 1116 Pages. 1400 Illusts.
Write for "Dictionary Wrinkles," and Specimen Pages, FREE. Mention in your request *this magazine* and receive a useful set of Colored Maps, pocket size.
G. & C. MERRIAM CO., Springfield, Mass.

GAS ENGINE MANUAL


5½IN
AUDELS GAS ENGINE MANUAL
PRACTICAL TREATISE WITH ILLUSTRATIONS AND DIAGRAMS
8½ INCHES

¶ This volume just published gives the latest and most helpful information respecting the construction, care and management of **Gas, Gasoline** and **Oil Engines, Marine Motors** and **Automobile Engines,** including chapters on Producer Gas Plants and the Alcohol Motor.
¶ The book is a practical educator from cover to cover and is worth many times the price to any one using a gas engine of any type or size. Contains 512 pages, 27 chapters, 156 diagrams, size 5½ x 8½ inches, weighs 2 pounds, handsomely bound, and is in every way a fine volume.
SPECIAL OFFER
¶ *The only way the practical merit of this* MANUAL *can be given is by* ***an examination of the book itself,*** *which we will submit to the readers of Engineering-Contracting, free for examination, to be paid for or returned, after looking it over.*
¶ Upon receipt of the following agreement (which can be either cut out or copied), the book will be immediately forwarded.
No money in advance required, sign and return
Theo. Audel & Co., 63 Fifth Ave., New York
Kindly mail me copy of "Audels Gas Engine Manual," and, if found satisfactory, I will immediately remit you $2.00, or return the book to you.
Name .... Address ....
E. C.

BOOK REVIEWS.

How to Use Slide Rules. By D. Petri-Palmedo. Kolesch & Co., New York. Cloth. 4¼x7 ins., pp. 52, illustrated; 50 cts.

This book tells in simple and clear language how to use the Mannheim slide rule in making all the ordinary calculations for which this useful instrument is suitable. The author describes the instrument in its various improved forms, explains the principle on which it works and then takes up in order or complexity the various classes of calculations, beginning with simple multiplication and division and working through combined multiplication and division, squares, cubes, units, trigonometrical functions, etc., to compound calculations. The book will be found useful to both the beginner and the experienced user of the slide rule.

Electrical Railroading as Applied by Steam Railways.—By Sidney Aylmer-Small Frederick J. Drake & Co., Chicago. Leather, 5¾x7 ins.; pp 924; illustrated; $3.50.

This book should prove useful to a wide circle of railway employees. As the electrification of steam roads proceeds there will be a constant call for men familiar with the new power and the mechanism by which it is transmitted and applied. The author argues that the present steam railroad man is the one who can best supply this demand if he will only make himself as familiar with the new power as he is now familiar with steam railway mechanism. This book has been prepared as a self-instruction book for this class of men. It is not a treatise for the trained electrical engineer. Its arrangement is that which was long ago adopted by the late M. N. Forney for his "Locomotive Catechism" and since used by a number of writers of railway instruction books; the information is presented in the shape of questions and answers. Beginning with general definitions and statements of principles the author proceeds to specific machines and details. At intervals between lessons descriptions are given of apparatus and machinery, these descriptions being arranged to review the knowledge acquired from the previous lessons. The subjects treated relate to line construction as well as to cars and motive power. Altogether the book is well fitted to the purpose for which it is intended.

Principles of Reinforced Concrete Construction. By F. E. Turneaur and E. R. Maurer. John Wiley & Sons, New York. Cloth; 6x9 ins.; pp. 313; illustrated; $3.

In their preface to this book the authors state its purpose to be to present in a systematic manner those principles of mechanics underlying the design of reinforced concrete, to present the results of all available tests that may aid in establishing coefficients and working stresses and to give such illustrative examples from actual practice as may be needed to make clear the principles involved. The book is a treatise for the designing engineer in every particular and for this class of workers it is excellent. Briefly Chapter II presents the properties of materials—concrete, steel and concrete and steel in combination; Chapter III discusses the theory of reinforced concrete. Tests of beams and columns are recorded in Chapter IV and in Chapter V and VI the preceding information is wrought into working stresses and loads and working formulas for computing columns and beams. The remaining four chapters belong to the portion of the book defined as illustration examples. They consider buildings, arches, retaining walls and dams and miscellaneous structures.

Standard Handbook for Electrical Engineers. Written and compiled by a staff of specialists. McGraw Publishing Co., New York. Flexible leather, 4¼x7 ins.; pp. 1283; illustrated; $4.

'This book occupies a field not already well occupied and fills it with unusual completeness. Unlike other standard handbooks with which engineers are familiar it is the work of a staff of authors and editors each member of which prepared some one or more parts or sections under the general direction of an editor and according to a previously mapped out schedule of work. The plan has its faults as well as its advantages and these faults are occasionally evident in the present book. Taking it as a whole however electrical enginers have in this book a manual which ranks high in both quality and scope with the very best handbooks in other fields of engineering. The several sections of the book are: Units, Electric and Magnetic Circuits, Measurements and Measuring Apparatus, Properties of Materials, Magnets, Transformers, Electric Generators, Electric Motors, Batteries, Central Stations, Transmission and Distribution, Illumination, Electric Traction, Electrochemistry, Telephony, Telegraphy, Miscellaneous Applications, Wiring, Standardization Rules, Tables and Statistics.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0645. **Novoid.**—Abbey-Dodge-Brooks Concrete Co., Newark, N. J.

A circular setting forth the merits of this waterproofing compound for concrete and also concrete machinery sold by this company.

No. 0646. **Phoenix Portland Cement.**—Wm. G. Hartranft Cement Co., Real Estate Trust Bldg., Philadelphia, Pa.

A 60-page pamphlet setting forth the merits of Phoenix cement. It is asserted that this is the finest ground cement on the market. Ten tests for fineness are given and much other cement talk. This cement is subjected at the mill to every known test before being shipped. The pamphlet is illustrated with many half-tones of structures in which Phoenix Portland cement has been

No. 0647. **Old Dominion Portland Cement.**—Wm. G. Hartranft Cement Co., Real Estate Trust Bldg., Philadelphia, Pa.

An 84-page catalog devoted to illustrating the important buildings and structures in which Old Dominion cement has been used during the past few years, including the making of concrete piles, tiles and chimneys. Contains report of committee of the American Society for Testing Materials on uniform specifications for cement. The specifications having been adopted by the Association of American Portland Cement Manufacturers and the American Railway Engineering and Maintenance of Way Association.

No. 0648. **Galvanized Cans.**—The Arrow Can Co., 35 Warren St., New York.

A folder illustrating a strongly made galvanized ribbed can, for ashes, garbage, waste paper and many other municipal purposes. This company also manufactures cans for varying sizes for oil and gasoline.

No. 0649. **Does Metering Pay?**—McWane Pipe Works, 220 Broadway, New York.

A folder calling attention to the reduction of water rates at Danville, Va., through the use of meters, the value of which has been increased by placing them in the McWane Meter Box, which is set in the sidewalk, making it accessible at all times.

No. 0650. **Contractors' Lights.**—Alexander Milburn Co., 507 W. Lombard St., Baltimore, Md.

This 16-page catalog illustrates and describes the Milburn Acetylene light for contractors, railways, sewers, circuses, factories, mines, homes, churches and many other purposes. The contractors' lights are storm, wind and waterproof, flame can be swung at any angle, and the light is easily moved from place to place. It is said that the lights cost 1½ cts. per 1,000 candle power per hr. and they are exceedingly simple to operate.

No. 0651. **Calculating Machine.**—Oscar Muller & Co., 32 Broadway, New York.

A folder telling of the use of "The Unitas" calculating machine. It is stated that this is the most compact, noiseless, accurate, rapid and simple of operation, of all calculating machines. It is meant for engineers and business men. It is not a cheap machine, but inasmuch as it saves so much time in making all kinds of operations, it quickly pays for itself.

No. 0652. **Gas, Oil and Alcohol Engines.**—August Mietz, 128-138 Mott St., New York.

A 42-page catalog descriptive of the Mietz & Weiss engines. A number of drawings are given to illustrate the operation and care needed by these gas and oil engines, and tables are given, showing the size, horse power, etc. Pumps, hoists and other machines operated in connection with these engines are also shown.

No. 0653. **Road Making Machinery.**—Charles Longenecker & Co., 150 Nassau St., New York.

Folders illustrating and describing, steam road roller, macadam scarifier and Etnyre sprinkler. These machines are all meant for heavy road construction, and are substantially built.

No. 0654. **Saylor's Portland Cement.**—Coplay Cement Mfg. Co., Pennsylvania Bldg., Philadelphia, Pa.

A 16-page pamphlet telling of the merits of this cement. It is stated that Saylor's cement was the first Portland cement manufactured in this country, the first barrel being made in 1871; prior to that the company having made natural cement. A number of large structures in which this cement has been used are illustrated from photographs.

No. 0655. **Houses, Portable and Ready-Made.**—Ducker Co., 277 Broadway, New York.

A 24-page catalog describing and illustrating all kinds and sizes of portable houses, for various purposes. The slogan of this company is "Erected without nail or screw." The houses are made in sections and put together by anyone of fair intelligence. Used for dwellings, having a number of rooms in them, and with verandas, for hospitals, school houses, railroad stations, stables, churches, garage, factories and many other purposes.

No. 0656. **Ready Roofing.**—H. W. Johns-Manville Co., 100 William St., New York.

A pamphlet showing the advantages of ready roofing, and especially of asbestos roofing manufactured by this company. 12 pages are devoted to a description of this roofing and the uses to which it has been put.

No. 0657. **Concrete in Bee-Hive Oven Construction.**—The Cranford Paving Co., Washington, D. C.

This is a pamphlet by Charles L. Hower, describing the building of some concrete coke ovens at Nintondal, Pa. Concrete piles were used for the foundation, and the entire construction was of that material. The pamphlet is well illustrated and it is sent free to those interested.

No. 0658. **Comparison of Various Piles.**—Cranford Paving Co., Washington, D. C.

This is a 7-page pamphlet written by Thomas Mackellar on the various types of concrete piles. It is a trade paper being circulated by the above company, who will send it to those interested.

No. 0659. **Simplex Concrete Pile.**—The Simplex Concrete Piling Co., Tacony, Philadelphia, Pa.

A neatly printed, well illustrated 88-page book telling about the merits and use of the Simplex pile, which is made by driving a cylindrical steel form with a metal point into the ground, in which is cast a concrete pile, the form being pulled after the concrete is in place. This pile has been used on many jobs, and cuts are given of some of these structures. The composite pile is also shown, where a wooden pile is sunk to a depth where it cannot be injured, and on top of it, and forming a part of the timber pile is cast a concrete section. Such a pile is of use where shipworms injure wooden piling.

No. 0660. **Monolith Hollow Wall.**—Monolith Hollow Wall Co., Monolith Bldg., New York.

A bulletin telling of the Ham method of building hollow concrete walls, on the patented forms. These forms are of metal and build two walls, each monolithic, at the same time, they being tied together, both vertically and horizontally by metal ties.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

Boston Has Lost $1,000,000 Through Crushing Rock by Day Labor Instead of by Contract..............207

CONCRETE SECTION:

Some Defects and Limitations of Reinforced Concrete Construction....208
Methods of Constructing Reinforced Concrete Slope Paving for Holland Dikes 210

EARTH AND ROCK SECTION:

Method of Building a Small Cofferdam 212
Methods of Grubbing Stumps and Trees with Machines...............213
Steam Consumption in Air Compressors 215

GENERAL ARTICLES:

Letters to the Editors: A Problem in Excavation, What Tools to Use.215
Twelve Additional Letters Commending the American Society of Engineering Contractors...............217
Cost of an Artesian Well...........218
The Zuni Dam.......................218

METHODS AND COSTS:

Tension Wire Sweep—Constructing a 10-in. Sewer Under an 8-in. Sewer —Drilling a Hole Through a Wall —Locating a Cast Iron Pipe Line..216
CATALOGS WORTH HAVING.............218
PERSONALS 218

Boston Has Lost $1,000,000 Through Crushing Rock by Day Labor Instead of by Contract.

The Finance Commission of the city of Boston has made a report to the mayor showing that the city has lost $1,000,000 during the last 12 years by operating rock crushers. The commission reports that the city will save $100,000 annually by abandoning its crushing plants and by purchasing crushed stone in the open market. It recommends the sale of the crushers and the award of a five years contract to the lowest bidder for crushed stone.

History is simply repeating itself in Boston. The astonishing thing is that it takes so many repetitions to teach the public that a city, or a state, or a government can not compete successfully with individuals and private corporations. There is something fascinating to the public in the idea of "saving the contractor's profits" by doing work by day labor. But the fascination turns to dismay when the time comes to foot the bills.

The word "profit" is, in some respects, an unfortunate word, for it conveys the idea to most people of making money without effort. The peanut vender makes several hundred per cent "profit" on every bag of nuts he sells. Yet no one begrudges him his "profit," for it is self evident that he performs a service, and that his "profit" is really a payment for that service. Now a contractor's profit is in no essential different. It is a payment for a service. If the contractor is entirely eliminated, as in the Boston rock crushing case, some one must be hired to perform the service that the contractor would otherwise perform, namely, to organize the forces and act as business manager. Instead of "profit" the city pays salaries, and, by this change, strikes out every strong incentive to keep down the cost. Indeed, if the business management falls into the hands of politicians, as it does almost invariably in the long run, a reign of graft of one sort or another begins. But it is not necessary to have graft in order to get high costs under the day labor system. Men simply will not work with as great energy for a city, or even for any large corporation, as they will work for a contractor.

In this matter of contracting for crushed stone a few suggestions may prove of assistance to such cities as Boston. The contract for the stone must be drawn with great care and with perfect fairness, if low bids are to be received from responsible contractors. A few years ago the city of Baltimore contemplated crushing its own stone, because it was urged that the high prices bid by contractors indicated a "combination." The fact was that the specifications left it entirely at the option of the city as to how much stone it would need, when it would buy, and when it would require the stone to be delivered. The city would frequently order a large amount of stone to be delivered in a time so short that no ordinary crushing plant could turn out the product. Failing to get the stone promptly the city would buy what it wanted from some other source and charge the difference in price against the regular contractor.

One season's orders might involve an average wagon haul of a mile, and then another year it might be two miles, but the contract made no provision for a sliding scale price depending on the length of haul. No one could foresee what the city might require, so year after year the price of broken stone mounted higher and higher, as one contractor after another got "stung" under the unfair and indefinite specifications. Finally, the city was on the verge of crushing its own stone, when the city engineer came out strongly against it and proved how enormously expensive it would be by producing actual records of cost of crushing stone in his own department by day labor.

A contract for crushed stone should state the point of delivery. If stone is to be delivered at various points by wagon then a sliding scale should be provided, preferably giving a price for stone f. o. b. wagons at a given place plus a price per 100 ft. or per mile of haul therefrom.

The clause governing the delivery of stone should state the maximum amount that may be required in any week.

The sizes of stone should be specified in such a manner as to cause little or no waste product. By rejecting certain sizes the city can readily force itself to pay a very high price for the grades that it accepts, unless it happens that the contractor has a ready market for the sizes not ordered by the city.

If engineers would consult with contractors in matters like this they would usually receive lower bid prices.

The life of power plant is given by Mr. Charles T. Main, mill engineer, Boston, Mass., as follows: With good water and good care, running about 12 hours a day, the life of a boiler should be about 20 years, or the depreciation 5 per cent a year. Slow-speed engines, running 10 hours a day, can be estimated as having a life of about 25 years, or a depreciation of 4 per cent a year. High-speed engines are much shorter lived, and will not average over 15 years, or a depreciation of about 7 per cent a year, and oftentimes it is greater when run 10 hours a day. The depreciation when run 20 to 24 hours a day is correspondingly greater. Boiler settings and piping should be included with the boilers, and engine foundations and piping with the engines. The life of economizers varies with the initial temperature of the entering water from about 10 years up to 40 years.

Three contracts for improvement of the State Barge Canal are now being advertised by Mr. F. C. Stevens, State Superintendent of Public Works, Albany, N. Y. The total estimated cost of the three contracts is $5,211,000.

The preservation of macadam roads by means of dust preventatives will form the chief investigative project of the U. S. Office of Public Roads for the fiscal year 1909.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Some Defects and Limitations of Reinforced Concrete Construction.*

BY MESSRS. M. S. FALK, RUDOLPH P. MILLER, EUGENE W. STERN AND H. C. TURNER.

M. S. Falk, Assoc. M. Am. Soc. C. E.

A considerable number of reinforced concrete structures have of late been described with enthusiasm before this society and in the technical press, and many, if not all, of the published descriptions make it appear that these structures have been a complete success from the time of their inception, causing no trouble to designer, owner or contractor. As a rule, these descriptions cover the completed structure only, and omit references to the difficulties and dangers encountered during construction. Candid statements of facts in relation to the use of reinforced concrete are absolutely necessary at the present time; such statements must be accurate, and should conceal nothing, so that they may serve as guides to others who propose this construction for similar classes of work.

Two buildings, entirely of concrete, were built during 1907, are now in use, and, to any observer, would appear to be eminently satisfactory. In neither case will the respective owners repeat their experiences, since in both instances they have learned that different methods would have afforded structures which could have been erected more quickly, at less cost, and would have been fully as permanent.

One building is an ice storage house, the outside dimensions of which are 58 by 92 ft., with a clear inside height of 42 ft. 8 ins. from the top of the basement floor to the under side of the roof slab. The columns supporting the roof are 18 by 12 ins. in cross-section, and are embedded at intervals of about 11 ft. in the curtain walls, which are 12 ins. thick for the exterior and 10 ins. for the interior walls. The building, which is to store cakes of manufactured ice, contains three chambers running the full length of the structure, the only entrance to each being through a small ice chute in the front of the building. There are no windows. At first study, any engineer would claim such a structure to be ideal for reinforced concrete; forms for vertical walls and for one roof slab only were required. The history of the case, however, refutes this.

The building was planned by an architect, who called for proposals, requiring the bidding contractors to design the reinforced concrete work subject to his approval, although he himself wrote the specifications under which the work was to be built, and prepared preliminary plans showing his ideas as to reinforcement. One of the requirements was that the walls and columns were to be designed to withstand an assumed horizontal thrust due to the pressure of the ice. Consequently, the columns were designed, by the contractors to whom the work was awarded, as vertical beams loaded at their centers with the ice thrust. The rods forming this reinforcement ran, for the most part, the full height of the building, and, as they were not self-supporting, it was necessary to build a wooden structure to hold them before any concreting work was done.

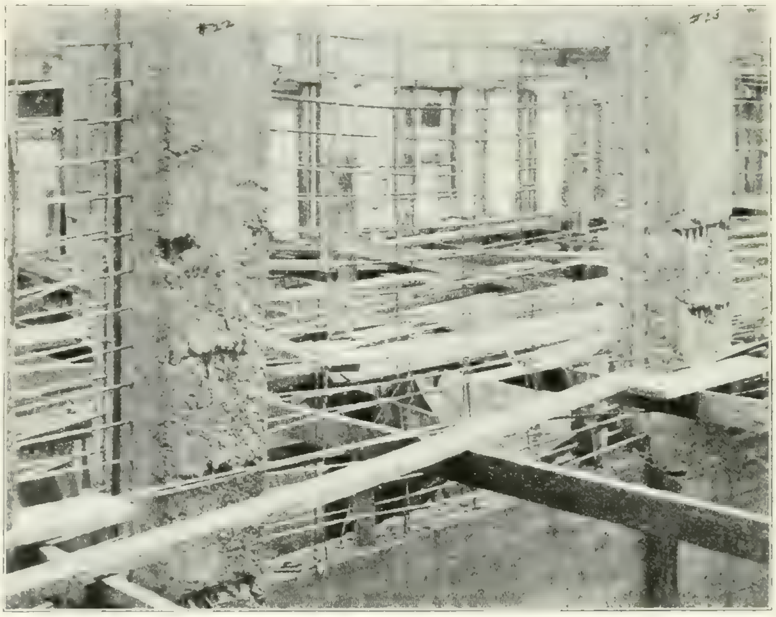


Fig. 1—Example of Defective Concrete in Molding Columns.

The rods in the columns were hooped together at short intervals, not only by outside wires, but also by wires crossing through the center; moreover, in order to space the corner column rods away from the forms, the contractor inserted plate-washers on each corner rod. The curtain walls were also reinforced with horizontal and vertical rods spaced and wired. The reinforcement acted as a screen through which the raw concrete was forced to pass.

One clause of the architect's specifications read as follows:

"The centering for columns shall not be over half the height of the building before concreting is commenced and for enclosing walls not over 10 ft. in height, unless otherwise approved.'

Although the contractor should have known better, he blindly attempted to follow this clause. The final results of the work, taken in connection with the design, are shown clearly in Fig. 1 and require no explanation, except that when the forms for the lower portions of the walls were stripped, the owner, mistrusting both contractor and architect as to the safety of the work, called for engineering advice.

The structure was completed, after much difficulty, strictly according to plan; dangerous defects were repaired so that no failure may be expected, and surface blemishes were plastered so that anyone not familiar with the actual construction might believe the building to be an example to be followed.

The second building was originally designed by an architect as a frame building to be finished in cement stucco; but a reinforced concrete contractor convinced the owner that it would cost but little more to make the building entirely of concrete, and he was given the order to proceed. In fairness to the architect, it should be stated that he was not consulted as to the building after the original plans had left his hands.

When the structure had reached about half way to the second story the owner began to suspect the character of the work which was being done, and decided to complete the building by day work in charge of an engineer. No difficulties out of the ordinary were encountered until the roof was reached.

The building is 40 ft. square, and there are four interior columns. The roof is a concrete slab, sloping at about 45° from the horizontal, and is supported on the side-walls and on two concrete beams running the length of the building and carried by the concrete columns. The concrete in the main portion of the building had been poured very wet; but when this mixture was placed on the sloping roof forms it refused to stay in place. Therefore, wooden planks had to be placed on top of this concrete in order to hold it down. This method, however, was exceedingly difficult, as the roof was a dangerous place for the workmen. The concrete was changed to a drier mixture, but still required the use of the outside forms. As it was impossible to lay very much of the roof in one day, there were many joints. After the concrete had set so that workmen could move about without injury to it, a surface coat of mortar, in which was incorporated a so-called water-proof compound, was placed. This coat was colored with red oxide of iron, so that the final surface showed a pleasing red. The surface coat was plastered smooth, and it seemed as though all water would be easily shed. The first rain storm, however, showed that the roof leaked almost like a sieve. It must be remembered that this work had been done by day labor, and not by contract, and that there had been absolutely no incentive for any but the best workmanship.

---

*Abstracted from an informal discussion printed in the Proceedings, American Society of Civil Engineers, March, 1908, p. 297.

The speaker consulted several waterproofing companies, asking them to waterproof the roof without destroying the color effect which had been obtained, but not one of these companies would take the work and guarantee it for more than one year. The use of pitch or similar water-proofing material was not permitted on account of the color, nor does the speaker believe that any plastic material would stay on this roof. It was finally decided to apply alum and soap, as in the Sylvester process, and from its application up to the present time the roof has shed the rain. It has not yet passed through both a summer and a winter, and it will be interesting to note what effect the temperature will have on a thin slab of this kind. The speaker would not advise any one to use a reinforced concrete roof of this kind.

Rudolph P. Miller, M. Am. Soc. C. E.—In the speaker's experience along the line of building construction, the success of reinforced concrete in engineering work is greatly dependent on thorough and intelligent inspection. Many a good design has been completely defeated because of the lack of proper superintendence. The materials being used at the present day in this kind of work are generally reliable, but their improper handling has often been responsible for poor results. It is desired to call attention here to two defects that have been of too frequent occurrence, which can be avoided by a little foresight in the design and by intelligent supervision in the construction. First, the displacement of the reinforcement when the concrete is placed; and, second, the formation of cavities in the concrete construction due to complicated reinforcement.

It would seem unnecessary to call the attention of engineers to the danger of the displacement of reinforcing rods or bars in reinforced concrete beams. Concisely stated, if the displacement is upward, there is a loss of strength proportionate to the amount of displacement; if the displacement is downward, the fire-resisting qualities of the construction are impaired, and ability to resist fire is one of the main claims of superiority of reinforced concrete construction. Judging from experience, however, it seems to be important to call the attention of engineers to the necessity of making provision for preventing the displacement of the reinforcement. It is the speaker's opinion that, no matter how carefully bars or rods are placed in the molds, or what precaution is taken in the pouring of the concrete, there can be no assurance that the reinforcement is in its proper position when the work is completed, unless some means have been used to prevent a movement. The only certain method that has come to the speaker's attention is that used in the so called "unit" systems, in which all the reinforcing bars or rods in a beam (and it is equally applicable to column construction), including the stirrups, are secured by heavy wire clamps or other devices in such a way that their relative positions cannot alter. By using washers or spacers the resultant frame can be secured in the forms against a bodily displacement, and held at a proper distance from the outer surface of the finished concrete.

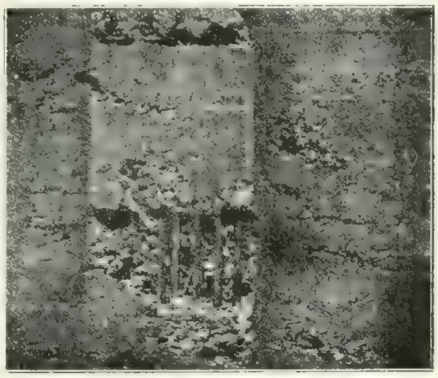


Fig. 2.—View Showing Cavities in Column.

Besides assuring the correct position of the reinforcement, the use of the unit frames greatly simplifies the superintendence of the construction. It requires but a glance (comparatively speaking) to see whether all the reinforcement is in place in the form and whether the proper frame is in each form. The frame having been built up from detailed drawings, previously prepared, the danger of the omission, occasionally of a bar or rod, of the substitution of a bar or less cross section, or of the use of too short a bar, is practically eliminated. The frames themselves may be fabricated at the shops and shipped to the job, or if the operation is sufficiently large to justify it there may be a temporary shop on the premises. The particular advantage in this is that the forms can be inspected and checked before they are put in place.

The second detail of construction which seems to have escaped attention is the avoidance of too complicated a reinforcement. In the disposition of the steel, care must be taken that the several elements are so closely spaced or so arranged as to prevent the concrete from pouring between and around them and thus producing cavities. The size of stone used in the aggregate should be considered in connection with the spacing of the rods, or *vice versa.* When complicated reinforcement cannot be avoided, the size of the stones should be reduced to suit the condition, or the stone should be eliminated, and mortar should be used. All this applies particularly to column construction and other work where the concrete must fall through considerable height. The speaker has seen a column the cross section of which was not more than 20 per cent of its embedded area, because of the cavities formed by the sieve-like action of the reinforcement. An instance of what is meant, though not as serious as the case referred to, is shown in Fig. 2.

Eugene W. Stern, M. Am. Soc. C. E.—No structural material in recent years has temporarily won such enthusiastic partisanship or caught the public eye to such an extent as reinforced concrete. It is useless to consider all the claims that have been made for it, but one in particular should be flatly contradicted, which is that but little special knowledge is required in the art of working in this material, and therefore that it can be largely done by unskilled labor.

A matter of interest in connection with the construction of reinforced concrete work is that contracting firms or those who exploit patented or deformed bars are largely responsible for the designs which go into buildings to-day. They submit their own plans, based on the use of these bars or some special method of construction, under some kind of guaranty as to carrying capacity, almost always without any charge for their services. It is the speaker's experience that this method leads to trouble, very often to a lawsuit. The client's interests are supposed to be looked after by the contractor, but when any trouble happens his interests of course are forgotten.

It is more than ever necessary in the use of this material that the structural design and supervision of the work should be placed in the hands of competent professional engineers who represent the owner's interests only. In no other material of construction is such extreme care necessary and such intelligent, constant and painstaking supervision required in every part of the process.

Reinforced concrete is a valuable material for use in structures, and has a large field. It has its limitations, however, and often, owing to the enthusiasm of its advocates, has been used where other materials would have answered the purpose better.

As a facing for buildings it has not proven a success, for the reason that it is difficult to obtain a pleasing surface, and ordinarily is more expensive than brick. In the construction of high buildings, the speaker believes that it is not as suitable for columns and girders as steel frame construction. For low buildings or factory and mill buildings occupying large areas in outlying districts, where there is plenty of room to handle the material, it has proved a very desirable substitute for mill-constructed buildings.

Among the faults of reinforced concrete work is its tendency to crack, due to the shrinkage of the concrete. The speaker has had to deal with a number of reinforced concrete buildings and none of these has been free from cracks in various places. A recent case was interesting. In a building there were two rows of columns longitudinally, dividing it into three bays. In the center, between the columns, there were heavy girders, but in the outside bays, for structural reasons, there were in places light girders. The heavy girders, in shrinking, drew the columns slightly together and the outside girders cracked in the top flange.

The illustrations shown by Messrs. Falk and Miller are interesting in showing what actually happens in practice. The speaker, however, has seen much larger voids in columns than any of those illustrated. In one case, where deformed bars having prongs were used, there were voids in the columns which practically occupied the whole area of the column. There was no attempt on the part of the contractor to scamp his work, but the interlacing of the prongs formed a screen which held up the stone and prevented it from becoming well consolidated in the mixture, with the above result.

The use of reinforced concrete for railroad bridges does not seem to be a proper application, for the reason that constant vibration would tend to cause cracks ultimately and separate the reinforcement from the concrete. Where conditions would be favorable to the rusting of steel, reinforced concrete is not suitable, unless cracking can be prevented, as otherwise reinforcement will ultimately rust out.

H. C. Turner, Assoc. M. Am. Soc. C. E. —During this discussion a number of questions have been raised which call for an answer by those who are closely identified with the construction of reinforced concrete buildings.

In answer to Mr. Stern's question regarding the preservation of the steel reinforcement in concrete structures, the following is the experience of the Turner Construction Co. in razing a one story building, erected for the J. B. King Co. at New Brighton, Staten Island, in 1902, which was taken down during the summer of 1907 to make room for a larger structure. The building had reinforced concrete walls, 9 ins. in thickness to grade line and 5 ins. in thickness from grade line to roof line, reinforced concrete interior columns, 11 ins. square, and reinforced concrete beams, girders, and roof slab. The foundation consisted of spruce piling, cut off at mean tide and capped with reinforced concrete. All steel reinforcement was found in perfect preservation except a few ¼-in. hoops in the wall columns, which were within ¼ to ½ in. of the surface. These showed slight corrosion, which would indicate that it is important to secure all steel reinforcement at least ¾ in. from the exterior surface. The steel in the footings, although alternately wet by the tide each day, was in perfect condition. In some cases this steel was within ¾ in. of the surface. Numerous observations of a similar kind have been made by engineers, and it is now generally recognized that steel reinforcement is permanently preserved in concrete structures.

It seems unfortunate that illustrations of standard reinforced concrete work have not been shown, rather than those of generally defective work, although such illustrations are valuable in indicating the character of design and workmanship to be avoided. It must not be assumed, however, that they are typical of reinforced concrete construction. Much excellent work is being done in New York city and in all cities in the United States. Eight and ten story buildings are not unusual, and it is to be noted that these buildings have proven especially adaptable for heavy storage or heavy manufacturing.

As Mr. Miller has stated, it is perhaps more difficult to secure good workmanship than good engineering design. This is a matter of organization. Good workmanship should be required, and undoubtedly can be furnished. There is abundant evidence of this, and good workmanship costs but little more than poor workmanship. It is necessary to have a thorough and experienced organization of workmen, but this is just as true in any line of successful business.

Answering Mr. Miller's observations on the value of unit systems in reinforced concrete construction, the chief objection to them at present is the additional cost, which must be paid by the owners. Unit frames may relieve the architect or engineer of some anxiety and responsibility, but it is admitted that most of the important work in the United States has been done with the loose-bar system, and with a proper organization loose bars, so called, can be placed and secured in the work with absolute reliability. The owner looks for results, and should certainly be entitled to the difference in cost between buildings constructed with loose-bar systems and with unit systems.

There were in service in the United States on Dec. 31, 1905, about 1,400,000 sq. yds. of creosoted wooden block pavement.

Method of Constructing Reinforced Concrete Slope Paving for Holland Dikes.*

Reinforced concrete slope paving has been tried for sea defences for many years in Germany, France, and other countries, but in the majority of cases has not met with much success, owing to the facings of slopes being destroyed by the thrust of the soil under them, produced by extremes of temperature. Mr. de Muralt's method of facing slopes with concrete reinformed with sheets of expanded metal dates only from March, 1906, but has made rapid progress. The inventor claims for it the following advantages: (1) The construction and the principles upon which it is carried out prevent and obviate the mistakes and faults appertaining to previous concrete slope defences; (2) the remarkably simple construction allows of its being carried out by unskilled labor; (3) the resistance of slope protection on this system is very great; (4) the method is more economical than any other. These claims have been tested and substantiated by the author, who has superintended the construction of several slope facings carried out on the De Muralt system.

The following is a description of the principles upon which this class of slope defense work is carried out: The cracking of the facing in consequence of frost or heat causing thrust from the soil underneath is obviated by dividing the slope facing into small separate sections, the reinforced concrete facing being no longer monolithic, as is usual, but consisting of a number of separate slabs kept in place by a system of beams, the whole being constructed *in situ* with an extremely small amount of plant or form-work.

Mr. de Muralt's principle of building the beams on the slabs, and not the slabs on the beams, thereby weighing down the slabs by the beams, is not only different to other reinforced concrete systems, but has great advantages in construction, being simple and easy. Practically the whole of the concrete work can be done on the slope itself, very cheap and simple forms being utilized. The division of the slope facing is the ruling idea of the system of construction, and this is obtained by building beams all round and resting on the slabs.

The soil of the slope first requires to be carefully graded. Where the soil is sand or clay, which does not permit of being cleanly and accurately graded level, straw is spread on the slope to a thickness of about 1 in., this straw being kept in place by means of straw-rope binders arranged in parallel lines at intervals of 7 in. to 8 in. After the slope is thus leveled, two notched or stepped wooden beams, 10 cm. by 12.5 cm., are laid parallel to each other at exactly 1.8 m. distance apart, extending vertically up the slope (Fig. 1). The length of these stepped beams *d* is 2.8 m., sufficient to allow a sheet of expanded metal measuring 1.8 m. by 2.4 m. to fit exactly between each pair of beams and the top and bottom boards *f* (shown in Fig. 2), these latter being 4 cm. thick and resting against cleats C (Fig. 1).

---

*Condensed from an article by H. Huisman, Civil Engineer, Zierikzee, Holland, in "Concrete and Constructional Engineering."

The beams *d* having been secured in position by iron stakes *a* (Fig. 1), a thin layer of concrete 2.5 cm. thick is laid on the slope, and on this a sheet of expanded metal No. 14 *e* is laid. Instead of expanded metal a reinforcement of iron rods woven into meshwork can be used; but the greatest care must be exercised to see that the weaving is well done and the meshes truly formed; expanded metal is, however, cheaper and more reliable than iron rods. When the sheet of metal is in position, a board *f* (Fig. 2), with a fillet g, is placed between the beams *d* against the cleats *h* on the lowest steps of the notched beams. Boards are then placed on each step as the concreting is carried up the slope, they being retained in position by means of the iron handles *m* through which wedges *n* are driven. The concrete under board k^1 is carefully punned by means of iron rammers, the second step is then concreted, and so on until the whole slab is completed, step by step.

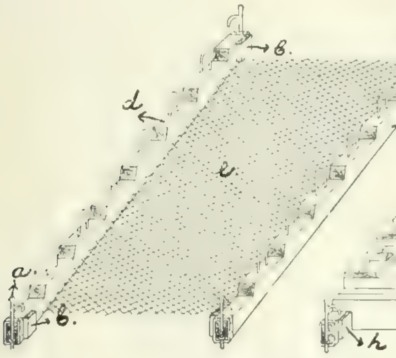


Fig. 1.—Two Stepped Wooden Beams in Position with Expanded Metal Between.

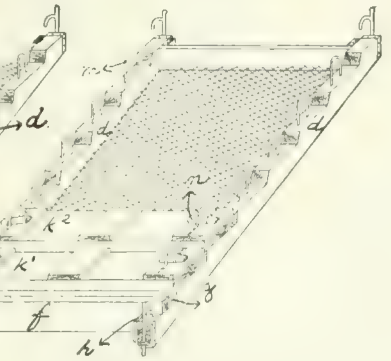


Fig. 2.—Showing Two Lowest Steps Concreted and Covered by Boards.

If the work is done in fine weather, the forms can be removed a few minutes after concreting, but when the work of construction is below tide level, so that the work is submerged at high tide, the wooden forms should not be removed for 24 hours.

The forms are all made of fir, and the iron stakes used to fix the beams in place measure 100 cm. in length and are nearly 1 in. in diameter.

Should the slope facing consist of more than one row of slabs, such as two parallel rows, the slabs would be concreted the whole way up the slope between two long notched or stepped beams, the slabs being separated by a horizontal space.

Fig. 3 shows a number of slabs in course of construction. Two sets of wooden beams *d* are fixed in position by means of the iron stakes *a*. Each set of large-sized beams *d* serves for the concrete of two slabs at a time. In order to keep the beams in place and the right distance apart, some of the covering boards—namely, the bottom one, the middle one (this covering at the same time two small boards, by which means the space required for the horizontal reinforced concrete beam is obtained), and the top board—are laid loosely on the handles m (compare also the boards, k^1, k^2, and k^3, shown in Fig. 4). Both panels between the beams in section 1 have already been given the first thin layer of concrete, and the workman is shown ready to lay the sheet of expanded metal reinforcement in the lower half.

As soon as the slabs have hardened sufficiently, trenches are dug all round the slabs to a depth of 15 cm. to 20 cm. below the underside thereof. Iron rods are laid in these trenches so as to form continuous reinforcement quite independent of the slabs. The foot is first constructed, and against this the sloping wooden beams d^1 are then put up, being laid on top of the slabs, leaving open part *p* of the latter.

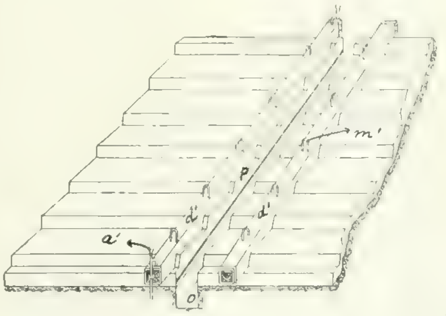


Fig. 3—Sketch Showing Trench and Form for Sloping Reinforced Concrete Beam.

These beams d^1 are also kept in position by means of iron stakes a^1, and measure 280 cm. by 10 cm. by 12.5 cm. The beams are also provided with handles m^1.

Fig. 4 shows the method of covering the facing slabs with boards *r* after the concreting is finished. If the slope is not steep and there are no tidal difficulties these boards can be left aside. The concrete must now be carefully smoothed and covered with straw or similar material to keep off the sun.

The reinforcement of the concrete framing beams, which are T-shaped, consists of iron bars 5/16 in. dia. placed near the bottom or underside, and sheets of expanded metal No. 15, at the top in the head of the T, carefully cut to fit exactly between the wooden beams, thus reinforcing the parts that overlap the slabs.

Immediately after the hardening of the concrete of the topmost beam the space behind is filled in with earth.

It should be borne in mind that the hardening of the slabs should have been continuing for some days before the construction of the steps can be commenced. Each time the edges, sides, and ends of the wooden forms should be well oiled to prevent the concrete sticking thereto.

All the slabs should be independent of one another and also of the framing. The reinforcing of the framing beams runs everywhere into one another at the junctions; therefore if one part of the framing should be raised, the total frame would rise and the slabs be left behind. The total mass of the framing of beams fixes the slabs on the slope, as its weight per sq. cm. is greater than that of the slabs. The foot of the facing needs to be carefully constructed and be watertight. When working on a sandy soil it is of the greatest importance to construct the footing before the slabs, in order to prevent the sand sliding down under the finished lower slabs under the action of water. It is also important when digging trenches in a sandy soil to thoroughly moisten the spaces left between the slabs before starting the work of trenching.

The De Muralt reinforced concrete slope-facing can also be applied on dry soil, with the use of only one wooden form for the construction of both slabs and framing beams.

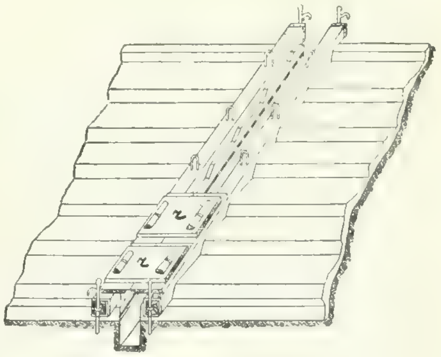


Fig. 4—Sketch Showing Form for Concreting Sloping Beam.

Should the work be undertaken on the seashore, where the tide continuously washes the slope, more wooden forms are necessary, because the slabs must remain covered during at least one tide, and the forms should be weighted with heavy rock to prevent them being washed away.

Since March, 1906, more than 80,000 sq. m. of reinforced concrete slope facing have been executed in the Netherlands, all on the now well known principles laid down by Mr. de Muralt.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Method of Building a Small Cofferdam.*

W. H. BOUGHTON.†

This cofferdam was no exception to the rule that all cofferdams give more or less trouble. The dam was used for the purpose of building a bridge pier in the middle of the Monongahela River at Morgantown, W. Va. The pier extends about 50 ft. above pool level and 12 ft. below pool level. The concrete footing is 2.5 ft. thick and about 16x58 ft. The contractor made his dam only 22x64 ft. on the inside, which seemed to the engineer to be too small for the possible conditions to be met. The risk of total loss of the dam was incurred in order to effect a comparatively small saving in its cost.

One frame for guiding and holding the sheet piles rested on the bottom of the river, and another was placed at the surface. Each one consisted of an inner and an outer rectangle made of timber hewed on two sides from about 10 to 12-in. logs. The inner and outer lines were held 7 ft. apart, and at intervals of about 10 ft. poles 5 to 8 ins. in diameter extended across the interior of the dam to prevent collapsing. The lower frame was loaded with rock and sunk. The timbers were spliced by being beveled, lapped and bolted by a single horizontal bolt. This allowed the frame to conform closely to the bottom of the river. The upper frame was placed in position and the two bolted together.

Sheet piles 2x4 ins. by 10 to 12 ft. were driven inside and against the frames. The piles were driven to refusal by hand, the penetration being only 6 to 12 ins. It was found impossible to drive any heavier piles at all. Wider pieces were placed over the 2x4s to cover open joints, but they were not driven far.

The material of the bottom was a very firm gravel containing many boulders. Previous investigation had indicated that rock must be near the bed of the river. Work on the construction of Dam No. 10, about one-fourth mile up the river, had disclosed a rock stratum all the way across the river, but with great irregularities in elevation, and this stratum had been used as foundation for the dam. A pit dug on the east bank of the river at the bridge site showed the same stratum 4 ft. below the river surface, and at the west side it was found nearly up to the surface. As the water was 6 ft. deep at the center it was suspected that a depression existed there and rock would be struck close to the bottom. Explorations with drills seemed to give the same indication, but, as it turned out, this was due to the numerous large boulders that were present. One boulder afterward uncovered in the excavation showed the mark of a churn drill on its upper surface, so it was thought that the piles had reached the rock. Had it been so, the pier would have cost about $1,600 less than it did, the contract being based on unit prices.

The space between the rows of piles was filled with material taken from the hillside without special selection and consisting of clay with gravel of various sizes. Several hundred loads were hauled on an old suspension bridge above and dumped into a long chute which was shifted so as to deliver the filling directly to different parts of the dam. As excavation proceeded material from the inside was dumped on the outside of the dam up to the surface of the water.

The first lesson taught by this example is that a proper mixture of gravel and clay is better than either material singly for filling a cofferdam. But emphasis must be laid on the word "proper." The worst leak in this dam and the most costly to stop occurred at one corner where the filling material, in flying so far from the end of the chute, segregated and the coarse material was delivered to the corner, while the fine material was dropped nearer the end of the chute. In an attempt to stop the leak at the corner additional sheeting was driven through the filling; manure was dumped outside and a tarpaulin was laid on the bottom and covered, but all without avail. It was necessary to build another coffer across the corner inside and then to excavate the original filling enough to get in a core of better material. The leak was then reduced, but not stopped. It continued in considerable volume at each end of this patched place. This occurred on Nov. 20-23, 1907.

The next most serious leak occurred where fine material was in excess, about 20 ft. from the above corner. It broke through at 2 a. m., Jan. 1, 1908, and was not stopped that day. It was necessary to stop the pump and let the water rise.

In other places when a new leak appeared it was only necessary to churn down a steel bar and puddle the hole a little to stop the leak, but where there was clay without gravel, whenever a hole was formed, instead of caving in, the clay arched it over so that it remained a channel for water and continually enlarged. Driving down a bar or sheeting was of no avail; a hole had to be dug down to the channel in order to stop it.

Another lesson the contractor should learn from this experience is the importance of providing for the worst conditions that may be met when the conditions are not all certainly known, instead of trusting to luck to have them all prove favorable to him. Had he in this case made his coffer 10 ft. wider it would have saved him many days and nights of worry. As it was, he barely escaped a serious loss. The stratum was reached that was entirely satisfactory. The space within the coffer was so narrow that to get in at the footing and leave a channel along the side of the sump it was necessary to dig down practically vertically. This exposed the points of the sheet piles and resulted in numerous leaks. The infiltration through the gravel below the piles increased, of course, and loosened the gravel till it caved in. In places the inner sills settled a foot or more. The river rose several times and stopped work, and after each rise the dam was found to be in a weakened condition. It would surely have been destroyed had it not been for the embankment on the outside. All connected with the job agreed that it would scarcely stand another rise. On Jan. 5, 1908, a very strong leak appeared, boiling up like a spring through the backfilling that had been placed after the first courses of stone were set, and promising to become interesting. But the same day the fifth course of stone was placed, which brought the pier above the river, and the pump was removed just in time for another rise.

Work has since been commenced on the east shore pier. The coffer runs along the river side only and consists of simply one row of sheet piling, with a good bank of earth on the river side and a sufficient bank on the inside also. The excavation was quickly carried down to the rock stratum first mentioned and the concrete footing put in. Work was stopped Jan. 27 by high water again, but prior to that there was no trouble with water. What little water came into the hole came from the land side. At the middle pier a 6-in. centrifugal pump was kept going 24 hrs. a day, while at the east side a diaphragm pump operated by one man five minutes every hour kept the water out of the way.

---

*Abstracted from a paper read before the Ohio Engineering Society.

†Morganton, W. Va.

On June 30, 1907, there were 159 national forests in the United States, aggregating 150,832,665 acres.

The cost of creosoted wood block pavement in the United States has varied from $2.40 to $3.50 per sq. yd. laid. The average cost of wood block pavement laid in 1905 in a number of cities reporting to the U. S. Department of Agriculture, was $3.10 per square yard. This cost includes the concrete base, but does not include excavation, curbing, etc.

Methods of Grubbing Stumps and Trees with Machines.

In our issue of March 25 we published an article on grubbing stumps and trees by four methods. In this article we give the method of doing this work by machines. Other articles on clearing and grubbing, giving methods and costs, have appeared in our issues of Oct. 17, 1907, Feb. 27, 1907, and Dec. 25, 1907.

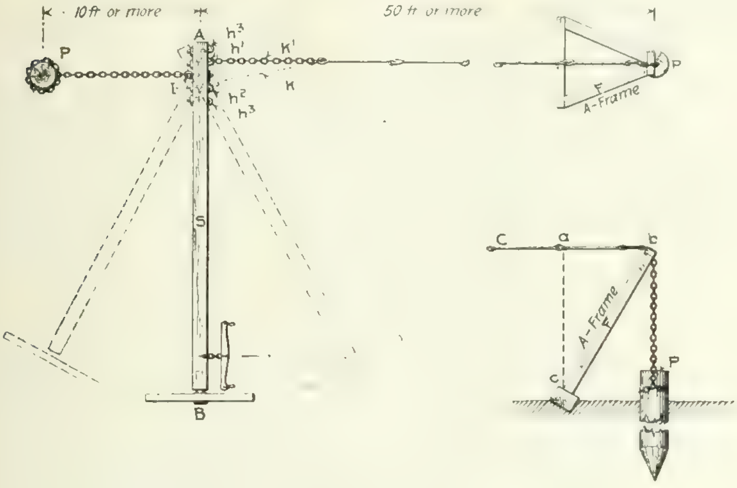


Fig. 1—Sweep Stump Puller.

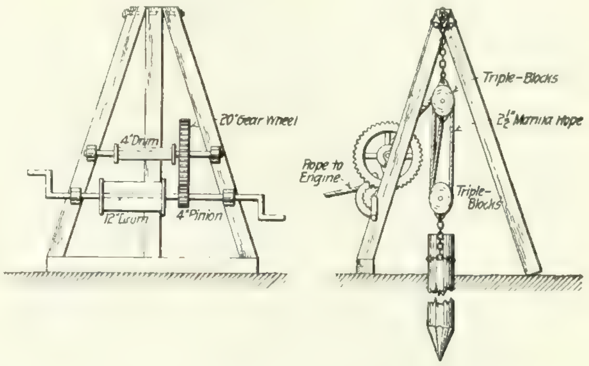


Fig. 2—Tripod Stump Puller.

A style of stump puller, known as the sweep stump puller, is shown in Fig. 1. Its operation is simple yet very effective. One end of the sweep S rests on the ground, and the other end is mounted on a wagon wheel. The sweep is an 8x10 in. timber 24 ft. long, and at the free end, B, there is attached a single or double whiffletree, as described. The arrangement at the fixed end, A, is somewhat more complex and may well be described in detail. About 3 ft. from the end is an eyebolt, I, to which is fastened an anchoring chain attached to a convenient stump or "dead man," P. On each side of the eyebolt, and almost 4 in. from it are attached hookbolts, h_1 and h_2, and still further away two similar bolts, h_3 h_4. The stump pulling wire cable is fastened to a short chain, K, and then carried over on A from F and attached to a stump as shown. The chain K is hooked to the bolt h_1.

In operating it the lever is drawn in the direction of the arrow, causing a strain on the pulling cable. The horse is driven ahead until the sweep has the position shown by the dotted lines, and when this position has been reached a short length of chain indicated by the dotted line K is hooked at one end to the pulling chain and at the other end to the hook holt h_2. The horse is then turned and driven in the opposite direction, putting a further strain on the pulling chain and slacking the chain K so that it can be shortened and hooked up again when the horse has moved the sweep to the position shown by the left hand set of dotted lines. The horse is then started on its forward trip, then back again, and so on, pulling alternately on chains K and K_1 and putting ultimately, an enormous strain on the stump.

An idea of the power exerted is gained from the following brief calculation. If the distance between the king bolt of the whiffletree and the bolt I is 20 ft., and if h_1 and h_2 are 4 in. (1-3 ft.) from I, the pull of the horse is multiplied $3 \times 20 = 60$ times. A horse capable of pulling 500 lbs. would then put a strain of $500 \times 60 = 30,000$ lbs. on the chain K and K_1. Then in the triangle a b c, a b represents 30,000 lbs. and a c represents the pull on the stump, which must always be greater than 30,000 lbs. to an amount depending upon the inclination of the A frame; if the batter of the A frame is 1 in 3 the pull on the stump will be 40,000 lbs. As a matter of fact, one horse cannot maintain a 500 lb. pull, and a team must be used where such a pull is necessary.

Very large stumps can be pulled with this simple device and a team of horses.

From the figures given it is evident that heavy chains and cables must be used or else there will be frequent breaks.

One set up of the machine can be used to pull a large number of stumps, since it is necessary to move only the comparatively light A frame. With a long cable, to give a good reach to the machine, there should be used take ups like those shown with the other style of stump puller (Mar. 25 issue), else considerable time is consumed in taking up the slack of the cable. The crew to operate this style of machine consists of a foreman, three laborers and one team, the cost varying from $10 to $15 per day. This machine and the one shown in Fig. 2 were both used by one of the editors of

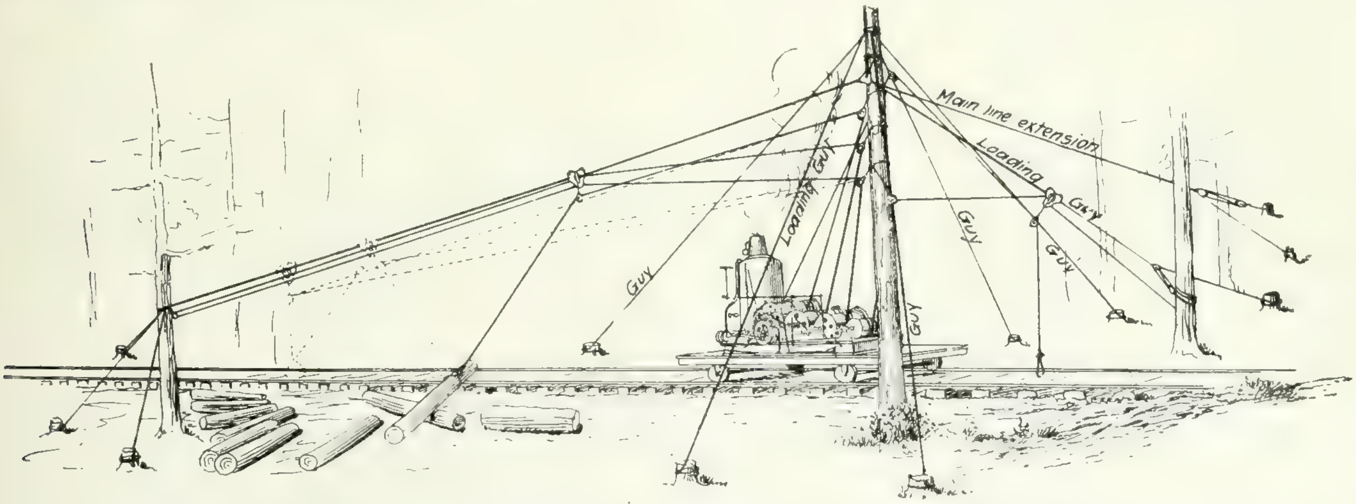


Fig. 3—Sketch Showing Rig for Log Skidding System, as Devised by the C. S. Flory Mfg. Co., Bangor, Pa.

this journal for pulling piles, the machines being adapted for either pile or stump pulling.

The legs of the tripod shown in Fig. 2 were 8x8 in. timbers, 10 ft. long. The rope is reeved through a set of triple blocks and carried to the 4 in. chain. The speed wheel and pinion are respectively 20 ins. and 4 ins. in diameter. This arrangement gives a powerful strain on the chain or cable fastened to the stump. The stumps can be pulled by hand power or horses, or a line can be run from the 12 in. drum to a small hoisting engine and the machine operated by it. This whole outfit, though, must be moved for each stump that is to be pulled.

A hoisting engine can always be used to good advantage in pulling stumps where there are many to pull. By means of a gear block and hooks it is easily rigged for the work. For this purpose the engine can be mounted on either a sled or on wheels and easily moved from place to place. These machines come mounted in this manner for logging purposes and are also mounted on railroad tracks and made self propelling.

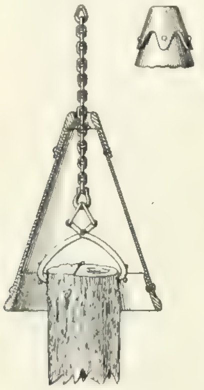


Fig. 4.

With such an outfit stumps can not only be pulled, but, with a small log skidding plant, both stumps and logs can be pulled up either to be burned or to be hauled away later on. A log skidder consists, besides the hoisting engine, of a gin pole or main spar, erected and properly guyed, with several cables carried to smaller poles, upon which a small carriage travels. The logs and stumps are picked up and dragged or lifted onto a pile around the gin pole.

Fig. 4, showing a McEwen patented cone, manufactured by the Floryman Co. This cone is slipped over the chain or cable used in pulling the log and prevents the log from plowing into the ground or lodging against obstructions. It is a useful device. When the pile is completed the blocks and cables are removed and the poles are burnt up with the pile of debris. The Lidgerwood Mfg. Co., of New York City, and the S. Flory Mfg. Co., of Bangor, Pa., make "log skidding systems" which are especially suited for clearing and grubbing by means of hoisting engines and cableway. See Fig. 3.

One of the editors of this journal once used a locomotive crane manufactured by the Browning Engineering Co., of Cleveland, to assist in grubbing and clearing up the right of way of a railroad. After the track was laid the crane was used to pull up small stumps outside the roadbed, but on the right of way and all the logs, stumps and brush were loaded on flat cars and carried to a marsh that was being filled in with earth and other materials.

No attempt was made to pull up a stump more than 10 to 12 ins. in diameter, as all the large ones had already been blasted, but the machine, rigged properly, could no doubt have pulled the largest stumps. The locomotive crane moved the car along as it was being loaded, and the crane was also used to help unload the cars. This was done by attaching a chain to one of the bottom logs or stumps on the side of the car farthest from dump and pulling this log or stump up and over, throwing off a great mass of the load at one lift.

TABLE I.—STEAM CONSUMPTION OF AIR COMPRESSORS; SINGLE STAGE COMPRESSION.

Pounds Steam Consumption per I. H. P. per hour	12	12½	13	13½	14	14½	15	15½	16	16½	17	17½	18	18½	19	19½	20	20½	21	21½	22
Air Pressure, Gauge 20	1 36	1 42	1 47	1 53	1 58	1 65	1 70	1 75	1 82	1 87	1 92	1 98	2 04	2 09	2.15	2 21	2 26	2 32	2 38	2 44	2 49
" " 30	1 84	1 92	1 99	2 07	2 14	2 23	2 30	2 37	2 45	2 53	2 60	2 68	2 76	2 83	2 92	2 99	3 06	3 14	3 22	3 30	3 37
" " 40	2 26	2 36	2 45	2 54	2 64	2 73	2 83	2 92	3 02	3 11	3 20	3 30	3 39	3 49	3 58	3 68	3.77	3 87	3 96	4 06	4 15
" " 50	2 62	2 74	2 84	2 95	3 06	3 17	3 28	3 38	3 50	3 61	3 71	3 82	3 93	4 04	4 16	4 26	4 36	4 49	4 59	4 71	4 80
" " 60	2 92	3 05	3 17	3 29	3.41	3 54	3 66	3 77	3 90	4 02	4 14	4 26	4 38	4 50	4 64	4 75	4 80	5 00	5 11	5 25	5 36
" " 70	3 22	3 36	3 50	3 63	3 76	3 90	4 02	4 16	4 30	4 43	4 56	4 70	4 83	4 96	5 11	5 24	5 36	5 50	5 64	5 78	5 90
" " 80	3 50	3 65	3 80	3 94	4 08	4 24	4 37	4 52	4 67	4 81	4 96	5 11	5 25	5 40	5 55	5 69	5 84	5 99	6 12	6 29	6 42
" " 90	3.72	3 88	4 06	4 19	4 34	4 50	4 65	4 80	4 96	5 11	5.26	5 43	5 58	5 73	5 90	6 05	6 20	6 36	6 50	6 68	6 82
" " 100	3.96	4.13	4 30	4 46	4 61	4.79	4.95	5 11	5 29	5 45	5 61	5 78	5 95	6 10	6 28	6 45	6 60	6 77	6 93	7 10	7.25
" " 110	4.18	4.36	4.54	4.71	4.87	5 06	5.22	5.40	5 58	5 75	5.92	6.10	6 26	6 45	6 63	6 80	6 96	7 15	7.31	7 50	7 66
" " 120	4 38	4 57	4 75	4 94	5 11	5 30	5 47	5 65	5 85	6 03	6 20	6 40	6.57	6.75	6.95	7 12	7.30	7.50	7 67	7 86	8 04

Pounds Steam Consumption per I. H. P. per hour	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Air Pressure, Gauge 20	2 60	2 72	2 83	2 94	3 06	3 17	3 28	3 40	3 50	3 61	3 74	3 85	3 97	4 08	4 18	4 30	4 42	4 54
" " 30	3 52	3 68	3 82	3 98	4 14	4 44	4 44	4 60	4 75	4 90	5 06	5 20	5 36	5 51	5 66	5 81	5 97	6 12
" " 40	4 34	4 52	4 70	4 90	5 08	5 26	5 46	5 65	5 85	6 03	6 22	6 40	6 60	6 78	6 95	7 14	7 35	7 50
" " 50	5 02	5 25	5 45	5 68	5 90	6 10	6.33	6 55	6.76	7 00	7 20	7.42	7.65	8 86	8 05	8.27	8.51	8.71
" " 60	5.60	5.85	6.08	6.32	6.56	6.80	7.05	7.30	7.55	7.80	8.03	8.27	8.52	8.76	8.99	9.22	9.50	9.71
" " 70	6.16	6.45	6.70	6.97	7.25	7.50	7.77	8.05	8.32	8.60	8.85	9.12	9.40	9.66	9.91	10 16	10.45	10.70
" " 80	6 70	7.00	7.29	7.59	7.86	8.15	8.48	8.75	9.05	9.34	9.62	9.92	10.20	10 50	10.75	11.05	11.36	11.61
" " 90	7.14	7.45	7 75	8 05	8.36	8.66	8.98	9.30	9.60	9.94	10.21	10 54	10.85	11.15	11.41	11.74	12.09	12.35
" " 100	7.59	7.92	8.25	8.58	8.90	9 22	9.57	9.90	10.20	10.56	10 90	11.20	11.55	11.88	12.16	12.50	12.85	13.15
" " 110	8.00	8.36	8 70	9 05	9 40	9 75	10 10	10 45	10 76	11.15	11 50	11 84	12 20	12 52	12 84	13 20	13 55	13.90
" " 120	8 40	8 76	9.11	9 50	9.85	10 20	10 58	10.95	11.30	11.66	12 05	12 40	12.76	13.13	13.45	13.82	14 21	14.55

TABLE II.—STEAM CONSUMPTION OF AIR COMPRESSORS; TWO-STAGE COMPRESSION.

Pounds Steam Consumption per I. H. P per hour	12	12½	13	13½	14	14½	15	15½	16	16½	17	17½	18	18½	19	19½	20	20½	21	21½	22
Air Pressure, Gauge 70	2.82	2 93	3 06	3 17	3 25	3 41	3.52	3 63	3 76	3 87	3 78	4 11	4 23	4 34	4 46	4 58	4.69	4.81	4.93	5 05	5 16
" " 80	3.01	3.13	3 27	3.39	3 51	3.64	3 77	3 89	4 03	4 15	4 26	4 90	4 52	4 64	4 78	4 90	5 02	5 15	5 27	5.41	5 53
" " 90	3 19	3 33	3 46	3.58	3 72	3 86	3 99	4 12	4 26	4 39	4 52	4 66	4 79	4 91	5 06	5 18	5 32	5 46	5 58	5 73	5 85
" " 100	3 73	3 51	3 65	3 79	3 93	4 07	4 21	4 35	4 50	4 63	4 77	4 92	5 05	5 18	5.34	5 47	5 61	5 76	5 90	6 05	6 19
" " 110	3 54	3 70	3 84	3.95	4.14	4.29	4 43	4 57	4 74	4 88	5 02	5 17	5.32	5 46	5.63	5.76	5.91	6 06	6 21	6.37	6.51
" " 120	3.69	3.85	4 00	4.15	4 30	4.46	4 62	4 76	4 93	5 08	5 22	5 39	5.54	5 69	5 86	6 00	6.15	6 32	6 46	6 64	6.78
" " 130	3.83	3.99	4.15	4.30	4 46	4 63	4.79	4 95	5 11	5 26	5 42	5 59	5 75	5 90	6 07	6 22	6 38	6 55	6 70	6 88	7 03
" " 140	3.96	4.13	4.30	4.45	4.62	4.79	4.95	5 11	5 29	5 45	5 60	5 79	5 94	6 10	6 28	6 45	6 60	6 77	6 93	7 11	7 26
" " 150	4.10	4.26	4.45	4.60	4.76	4.95	5.11	5 28	5 46	5 62	5 80	5 98	6 14	6 30	6 49	6 65	6 81	7 00	7 16	7 35	7 50

Pounds Steam Consumption per I. H. P. per hour	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Air Pressure, Gauge 70	5 39	5 63	5 85	6 10	6 33	6 56	6 80	7 04	7 26	7 50	7 74	7 96	8 20	8 45	8 65	8 90	9 15	9 35
" " 80	5 77	6 03	6 27	6 53	6 78	7 03	7 27	7 53	7 78	8 03	8 29	8 53	8 78	9 05	9 25	9 53	9 80	10 01
" " 90	6 10	6 38	6 65	6 91	7.17	7.44	7.70	7.98	8.24	8.50	8.77	9 03	9.31	9.57	9.81	10.05	10.35	10 60
" " 100	6.45	6.74	7.01	7.30	7.57	7.85	8.15	8.42	8.70	8.99	9.26	9.55	9.85	10.10	10.35	10.63	10.95	11.20
" " 110	6.80	7.10	7.40	7.70	7.96	8.27	8.58	8.86	9.16	9.46	9.75	10.05	10.35	10.64	10.90	11.20	11.51	11.80
" " 120	7 08	7.38	7.69	8 00	8.31	8.61	8.92	9.24	9.53	9.85	10 15	10.46	10.75	11.05	11.35	11.65	12.00	12.27
" " 130	7 34	7 66	7.97	8.30	8 61	8.92	9.25	9.57	9.90	10.20	10 52	10 84	11.15	11.48	11.76	12 10	12.42	12 72
" " 140	7 59	7.92	8 25	8 60	8 90	9.23	9.56	9 90	10 20	10 56	10 90	11.21	11.55	11.88	12.18	12.50	12.85	13.15
" " 150	7 84	8.17	8 51	8.86	9.20	9.55	9.90	10.20	10.55	10.90	11.25	11.60	11.91	12.26	12.58	12.90	13.28	13.60

The Clyde Iron Works, of Duluth, Minn., make the McGiffert log loader, which could be used for the same purpose. It has a long stationary boom. When loading the machine is elevated and stands on four steel beams, which allows empty cars to pass under it to take the place of the loaded ones. When not loading logs it is let down on its own trucks and is moved like a locomotive crane.

Upon another occasion a pile driving machine was used to clean up the right of way of a railroad. A pile bridge half a mile long was being built through a river bottom, and nearly the whole area was heavily wooded. The trees were cut down and sawed into logs, but the stumps were not grubbed. As the pile driver moved along driving the piles, by the use of two snatch blocks and some lines, all the logs and brush were moved off the right of way and piled on the adjoining land. This work hardly retarded the pile driving, as the men needed to trim and mark the poles did the work while the crew on the machine was preparing to drive the new bent of piles. From 10 to 20 ft. of right of way was cleared at each move of the machine.

Steam Consumption in Air Compressors.

The accompanying tables (page 214) showing the weight of steam required to compress 100 cu. ft. of free air to various gage pressures was compiled by Mr. O. S. Shautz of the Ingersoll-Rand Co., who furnishes them to us with the following comment:

"The tables are based on the various steam consumptions per indicated horsepower per hour shown at the head of each column. The computations are based on adiabatic compression in all the cylinders with a mechanical efficiency in the compressor of 90 per cent.

"The mode of using the tables is as follows: A steam consumption per indicated horsepower hour is assumed based upon an understanding of the type of steam end of the compressor, the steam pressure, cut off, vacuum if condensing, etc. Under this assumed figure on the line opposite the required air pressure will be found the pounds of steam consumed per 100 cu. ft. of free air compressed. The accuracy of these tables in practice depends upon the correct assumption of the indicated horsepower steam consumption. Where this can not be exactly determined the tables can at best be considered as only an approximation.

"The tables will, however, be found very useful for quickly making comparisons as to the amount of fuel consumed by the various types of air compressors, thus showing approximately the expected yearly saving by the use of, for instance, a compound with a simple machine. For example, a straight line compressor with a steam consumption of 30 lbs., single stage compression to 100 lbs. gage, requires 9.9 lbs. of steam per 100 cu. ft. of free air compressed. A compressor with duplex steam cylinders, at the same steam consumption, but with compound or two-stage air cylinders, requires 8.42 lbs. of steam. A compressor with compound steam cylinders, non-condensing, with a 26-lb. steam rating and compound air cylinders requires 7.3 lbs. of steam, while a high class Corliss compressor using steam at high pressure with compound steam cylinders running condensing with a water rate of 17 lbs. (including the condenser) and with compound air cylinders, requires 4.77 lbs. of steam, or one-half as much as in the first example.

"The average man, however, thinks in pounds of coal rather than in pounds of steam. For the purpose of comparison it will usually be better, therefore, to reduce deductions to terms of pounds of coal burned per hour or per day by dividing the steam consumption by 7, since a fair evaporation for average conditions is 7 pounds of water per pound of coal burned. This states the case upon a dollars and cents basis when the price of coal is known."

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

LETTERS TO THE EDITORS.

A Problem in Excavation, What Tools to Use.

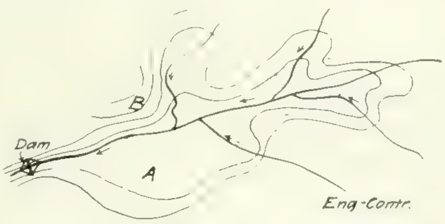
Sirs:—The writer is figuring on two pieces of dam construction work involving interesting problems of how to handle earthwork in the most economical manner.

Project A:

At the uuper end of a mountain stream is a narrow gateway or pass with steep, rocky sides forming a good site for a dam. Above this pass the valley widens out into a large flat meadow tract, with steep sides, and 10 to 20 ft. of clay soil on and below the creek level. (At A, see sketch).

What would be the best method to loosen this soil in the floor of the valley and transport and elevate it to the dam?

The average haul would be 500-600 ft. or more, the dam is 90 ft. high, 100,000 cu. yds. of dirt to be moved. There is some flow of water all the year round in the creek, plenty of firewood available. Horses cost $2.00 per day per team and are scarce, labor $2.00 to $2.25 for 8 hours. Capacity of plant should be 500 cu. yds. per day of 8 hours.



Project B:

Similar to Project A, but the floor of the valley contains no soil. The soil here is found in a "hogsback" at B, extending into the valley, some 800 ft. above the dam, and on such elevation, that for each level thee is soil enough above it for the required quantity in the dam.

In both cases the soil is a rather stiff clay, and is not readily hydraulicked. It does not flow till very wet, and when once liquid it stays slushy for considerable time.

Both jobs, being small, could not stand much plant cost. The question is, what would be the most economical plant to use, and how lay it out? Suggestions how to handle the work would be very welcome.

Engineers' estimate is about $60,000 each, including rip-rap, gates, etc.

Yours truly,

CONTRACTOR.

[The problems of earthwork presented by "Contractor" are interesting, but it is difficult with the limited information furnished to decide on the most economic method. *Project A.* The first work here should be to carry the flow of the stream either in a flume or pipe past the lower pit and through the embankment. This will prevent the water in the stream from flooding the borrow pit.

In developing the work, wheel scrapers may be used to advantage for awhile, as the haul would be short, and the base of the embankment if uneven or on rough ground can be very easily leveled with the scrapers. Scrapers, though, will not do for the great mass of the excavation.

As the material excavated has ultimately to be raised nearly a height of 100 ft. and the distance from the borrow pit to the embankment is only 500-600 ft., the use of steam traction is of doubtful application, as the grades will be necessarily steep. Considering the fact that the haul is short, and that any tracks on the embankment would have to be shifted frequently (due to the rolling in thin layers), and that the job is not large, horses and wagons will probably be best for transportation.

If the clay does not contain cobbles or boulders, the wagons can be loaded on the elevating graders, propelled by traction engines. For the engines' firewood and water can be easily obtained, but with wood, a fireman must be kept on the engine. Inasmuch as the excavation will run from 10 to 20 ft. in depth, it seems safe to assume that a breast can be made to the bank, this work being done with the scrapers, and a steam shovel used for loading the wagons. For this purpose we illustrated a hopper or dumping table, in our columns for Dec. 11, 1907, p. 331. The wagon is saved hard blows from the dipper by this device, and is also given a more evenly balanced load.

Project B. "Contractor" states that for this project the material is not readily hydraulicked, so this method will not be considered.

From the remarks made under the other project, it is evident that this is a steam shovel job, and as the grades in placing earth in the bottom of the embankment and also in the top, must necessarily be steep, horses and wagons should also be used for transportation.

For this work, a steam shovel could be hired, and also the horses and wagons. As it is frequently impossible to hire dump wagons, the contractor could buy dump boxes to be placed on the "hired running gears." This would effect a great saving over slat bottom wagons. The cost of outfit would be small if provided in this way.

For costs and methods of spreading earth and compacting it in reservoir embankments, see Engineering-Contracting, Feb. 12 and 19, 1908, pp. 99-102, 111-114.—Editors].

Methods and Costs; Some Old; Some New.

Tension Wire Sweep.—In searching for shoals and wrecks out in the open lake the U. S. Lake Survey uses a tension wire sweep that enables it to examine five to ten square miles in a day's work, sweeping and sounding at the same time. The sweep consisting of a little over a quarter of a mile of steel wire, or a small cable a tenth of an inch in diameter, is run out with a launch on each side of the survey steamer. The wire is buoyed every 100 ft., suspending it at 30 ft. below the water surface, and held down by weights. When each launch has its full length of wire stretched out, the steamer and the two launches wing-and-wing proceed on parallel courses. Each launch heads a little outside of its course, and in that way a tension of about 150 lbs. is maintained in the wire, which holds it taut and level. The sweep covers a belt half a mile wide, moves at a speed of about two miles, and so sweeps a square mile in an hour. At the same time soundings are taken from the survey steamer and both launches. Everything with less than 30 ft. of water on it is detected, whether it is a shoal, a boulder or a lone spar, reaching up from a deep lying wreck.

Constructing 10-in. Sewer Under an 8-in. Sewer.—In order to carry away the water from a recently constructed swimming tank it became necessary to lay a new 10-in. pipe sewer to replace the old 8-in. sewer. The work was done in an 18-ft. alley and required the construction of 250 ft. of 10-in. sewer and the keeping of an old sewer in commission until the new one was finished. The new sewer was laid 8 ft. below and directly underneath the old one. A trench 3 ft. wide was first cut down to the 8-in. sewer. 2 ft. of the trench being to one side of it and carried down to the required depth. Timbers, 6 x 8 x 14 ft., were placed across the cut and every 10 ft. a ¼-in. cable chain was put under the old sewer and up and over the 6 x 8 timbers. An equal strain was brought on the chains by tamping railroad fashion under the timbers. About 50 ft. of the old sewer was supported at one time. After the 50 ft. section had been supported, trenching was continued down by the side of the old sewer to the required depth. The old pipe was then cut under about 4 ft. and the first length of the new pipe laid, the end being inserted in a manhole. The earth was then shoveled from under the old pipe and tamped in on top of the new pipe. At a point where a connection was to be made a Y was put in and also a 4 or 6-in. pipe, extending upwards to connect the house, thus allowing the trench to be backfilled as the work progressed. When a 50-ft. section of 10-in. sewer had been laid and backfilled to the top of the old sewer, the timbers were moved ahead another 50 ft. and the work continued. A portion of the trench was in sandy soil and caved quite readily. The labor cost was about $200 or 80 cts per lineal foot. The pipe cost about $75 and cement cost $5, making a total of $280, or $1.12 per lineal foot. The old 8-in. pipe was worth about $25. The laborers were Mexicans, paid at the rate of about $1.50 per day. The work was done under the supervision of Mr. J. W. Hadlock, Sewer Commissioner, El Paso, Tex.

Drilling a Hole Through a Wall.—In installing the pipe line for the water system for some new buildings it was necessary to run a 10-in pipe horizontally through a river retaining wall 5 ft. thick. The hole had to be 28 ins. in diameter to allow the flange to enter with the necessary clearance. It was necessary to build a cofferdam to lay bare the wall at the required point. The work, therefore, had to be done as rapidly as possible. The method of drilling the hole was given in Mine and Quarry, from which the matter in this note has been taken. A Sullivan air hammer drill of the type used for stoping, with pneumatic cylinder feed and hollow steel, was mounted for this purpose, as shown in Fig. 1. A template was then made (Fig. 2) to start the holes and guide the drill. The end "A" consisted of 2-in. lumber mounted close to the wall, and containing a circle of 28 ½-in. holes, at equal distances, giving a space between each hole of or a little over three-eights of an inch. The end "B" contained an equal number of shallow holes in line with the holes in "A," for the reception of the feed-piston point. The drilling was accomplished in the usual manner, water being forced into the mouth of the holes instead of depending on the exhaust air for the removal of the chippings. By this means holes to a depth of 4 ft. and over were readily drilled. The remainder of the core was taken out from the other side of the wall with a Sullivan hand-operated hammer drill, used for drilling plug holes. When the holes were finished, the partitions were broached out by a mining drill with pneumatic feed and two light shots of powder removed the core. The actual time required for drilling was 13 hours. The drilling was begun without the water jet, and a material increase in the rate of speed was observed after the water was introduced. There was also an appreciable gain in the length of time the steel would run without resharpening.

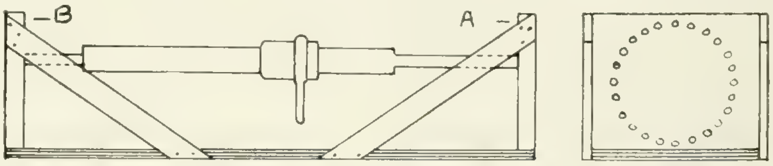


Fig. 1. Fig. 2.

Sketch Showing Mounting of Drill, and Template.

Locating a Cast Iron Pipe Line.—An improvised dip-needle was used in locating a 12-in. cast iron pipe buried from 2½ to 3 ft. The following description of the method employed is taken from the California Journal of Technology: It was desired to tap the line at several points in its course across a rolling field, but one point on the line being known, and the general direction. The soil was a stiff adobe, and saturated with water, making it very hard digging with a shovel. Believing that the friction in the pivots of an ordinary miners' dip-needle would be too great to show deflections, a more delicate needle was made by magnetizing a knitting needle, and balancing it in a loop of silk thread. Though a single fibre of silk was strong enough to support the needle, it was found to be too frail to handle in the field, and a strand of about ten fibers pulled from a skein of silk floss was used. To prevent slipping along the needle, a couple of half-hitches were taken round the balancing point, and glued securely. In order to have the two ends of the needle attracted with different force by the iron pipe, it was balanced so as to dip normally about 20 degrees when in a north and south position. The needle was mounted in a cigar box, with a single thumb tack, and a divided circle was sketched in at each end on which to read deflections. A glass cover kept out the wind. A vertical line was drawn from the point of suspension to serve as a guide in leveling the instrument. When used, the box was placed on the ground, and oriented into a north and south direction by allowing the needle to swing clear of the back of the cigar box on which it was mounted, and was made level by bringing the silk strand to coincide with the vertical line. The dip was then read to the nearest 32nd of an inch on the divided circle. By moving across the supposed line of the pipe, taking readings about 2 ft. apart, the pipe was located by an increase or decrease in the deflections. Owing probably to the fact that the pipe lay in a nearly north and south position, and was magnetized by the earth's induction, the amount of deflection at points directly over the line varied from nothing to about a quarter of an inch. Usually the reflection over a bell was about twice that over the middle of a section of pipe. Deflections of less than a 16th of an inch were found to be not conclusive, being probably due to inexact orientation or leveling, or wind. The attraction of a knife in the pocket was not sufficient to introduce a sensible error. The cost of the whole device was 11 cts., and the saving in labor was a matter of several days

Twelve Additional Letters Commending the American Society of Engineering Contractors.

In answer to the editorials and invitations extended to engineers and contractors to apply for membership in this proposed society, Mr. Gillette has received scores of letters advocating the formation of such an organization.

Applications are coming in rapidly the total number now exceeding 850. It would seem therefore that the permanent organization should soon be effected. An application blank can be found on page 5 of the advertising section. In our last issue we printed 12 letters commending the formation of this society; 12 additional letters follow:

Sir:

Find enclosed my application for a charter membership in the American Society of Engineering Contractors. I am very much interested in the formation of such a society and think it would be beneficial to both contractors and builders.

Very respectfully,
A. A. Ririe
Of Ririe & Mussenden,
Engineering and Contracting.
Roswell, N. Mex.

Sir:

Enclosed please find application, signed, for membership in American Society of Engineering Contracting. I believe if this society is formed it will fill a long-felt want and will be of great benefit to both contractors and engineers. I have read your editorials on specifications and if the society can get rid of specifications that may have filled the bill fifty years ago and get them up to date, it will not have been formed in vain.

Respectfully,
Wm. S. Beekman,
Castle Hill and Ellis Ave., Unionport, N. Y. City.
Ass't Engr. Bureau of Sewers, Bronx.

Sir:

I should like to subscribe to your proposed Society of Engineering Contractors when such is formed. You might let me have also a copy of your paper (sample) Engineering Contracting.

Yours faithfully,
Ernest H. Mitchell,
Rincon Antonio, Mexico.

Sir.

Enclosed you will find my application to become a member of the Americon Society of Engineering Contractors. From an observation and experience of 25 years, will say that the failure of many engineers is that due to misunderstanding what contractors have to overcome, and the proportion of costs for different parts of the work and their general experience account and this is largely also the failure of contractors, hence shall welcome anything that will make the duties of both better understood by each other. So far as time will permit, will try and serve the body when organized in a capable manner.

Yours truly,
F. H. Whiting,
Engineer and Contractor,
501 Continental Bldg.,
Denver, Colo.

Sir:

Inclosed please find application for membership in the American Society Engineering Contractors. I believe that it will be a great help both to the engineer and also to the contractor.

Yours very truly,
J. H. Fites
Civil Engineer,
Ottawa, Kan.

Sir:

I am desirous of becoming a charter member of the American Society of Engineering Contractors, provided the dues and conditions of membership shall prove satisfactory to me when they shall be decided upon.

Yours truly,
Edw. L. Holmes,
Gen. Mgr. Ferrolite Co., Bldg. Construction.
Chronicle Bldg., San Francisco.

Sir:

I attach herewith my application as charter member of the American Society of Engineering Contractors. I have read over very carefully the main object of the proposed society and, in my opinion, it is one society which the engineering and contracting world is very much in need of; principal item being securing accurate cost records and cost data.

I shall do all I can to encourage others in the profession to join the society and, if I can be of any help to you in this part of the country, will be glad to have you call on me.

Very truly,
C. H. Fisk,
Engineer M. of W. Frisco Lines,
Beaumont, Tex.

Sir:

I am inclosing application for membership in proposed American Society of Engineering Contractors. I note that in one of the published letters in Engineering Contracting for the week ending March 25, that one engineer makes application with the reservation only that "membership be restricted to engineers of standing." The wisdom of so doing can hardly be questioned. Otherwise the society will be instrumental in foisting numbers of incompetents upon the public. I have had eight years' experience, in railroad work; during which time I have held every position on the work from chainman to engineer in charge construction. Recently I have completed by contract, the building of twelve miles of track. If my experience renders me eligible to membership, then I should esteem it a great honor to be connected with the society. Trusting that you will be very successful in completing the organization, I am,

Yours very truly,
R. Emesh Beaty,
Of R. E. & F. N. Beaty,
Engineers & Contractors,
Georgetown, S. C.

Sir:

I enclose herewith slip for membership in the American Society of Engineering Contractors. Both engineers and contractors will derive great benefit from the organization of a society such as you propose. I wish you the greatest success.

Very truly yours,
David M. White, C. E.
Santa Fe, New Mexico.

Sir:

Enclosed find my application for charter membership in the American Society of Engineering Contractors. It is my belief that an association, such as you have outlined in a number of articles of explanation, which I have read with much interest, will be of immense benefit to contractors throughout the country and that it will have a rapid and healthy growth.

Yours very truly,
John H. Decker, C. E.
Gen. Man. Atlantic Con. & Supply Co.,
Atlantic City, N. J.

Sir:

I am desirous of becoming a charter member of the projected American Society of Engineering Contractors, provided the dues and conditions of membership are satisfactory, and enclose herewith a signed cutting from your magazine. I am at present a state road engineer, working for the highway commission of this state, but as I expect to enter the contracting field very soon, I am greatly interested in your society.

Yours very truly,
Walter H. Allen,
Box 56, Chehalis, Wash.

Sir:

Attached find my application to become a charter member of the American Society of Engineering Contractors.

Very truly yours,
J. J. Levin, Auditor,
Kenefick, Hoffman & Quigley,
Beaumont, Texas.

The chief engineer of the Board of Estimate and Apportionment of New York city has recommended that data relating to existing electrical subways and overhead wires be collected and that plans be prepared for a municipal conduit system.

Cost of an Artesian Well.

Mr. Wm. G. Fargo, consulting engineer, of Jackson, Mich., has furnished us with the following data regarding the cost of an artesian well:

The well was sunk at the Lansing, Mich., sub-station of the Commonwealth Power Co. It was 3 ins. in diameter and 107 ft. deep Of this deplth 50 ft. was through soft material and 57 ft. through rock. This meant that only 50 ft. needed sheathing, which was done by 50 ft. of 3-in. pipe at a cost of 32 cts. per foot, making a total cost for pipe of $16.

The well drilling machine, a small one, was hired for the work, 60 cts. per hour being paid for the use of the machine and the services of the man to run it. One laborer assisted this man in drilling the well. Record was not kept of the fuel used.

The cost was as follows:

71 hours' use of machine at $0.60	$42.60
69 hours' labor at $0.20	13.80
58 ft. 3-in. pipe at $0.32	16.00
Total	$72.40

This gives a cost per lineal foot of well of 67.6 cts.

For other data on the methods and costs of sinking artesian wells see ENGINEERING CONTRACTING May 23, 1906, and June 5, 1907.

The Zuni Dam.

The Zuni Dam was completed during the month of January, 1908. The dam proper is 90 ft. high, 450 ft. long, 410 ft. wide at base, and 30 ft. wide at top. It is a combination rock and earth fill, the rock laid up dry 140 ft. at base, 10 ft. at top. The dirt was put in by the hydraulic process, and is 270 ft. at base, and 20 ft. at top. The slope was covered with a foot of gravel, on which was placed 18 in. of rip-rap set on edge, and on top of this was placed another foot of gravel.

The water is drawn through a concrete tunnel 450 ft. long, which connects with a concrete gate tower 60 ft. high inside the reservoir. The reservoir when full will cover 640 acres, at an average depth of 35 ft. A spillway 100 ft. wide provides for the discharge of flood waters.

The labor was done by Navajo Indians, superintended by a few white men.

The Indians were taught to run the rock drills, which were made by the Wood Drill Works, Paterson, N. J.; and it speaks well both for the drills and for their operators that after several years of use the drills were in perfect condition.

The Zuni Dam was built by the Indian Bureau, under the direction of Mr. John B. Harper, M. Am. Soc. C. E., Superintendent of Irrigation.

The first use of wood for paving is said to have been in Russia, where rude blocks were laid several centuries ago. Wood was introduced into New York city in 1835-36 and into London in 1839.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0661. **Asphalt Ready Roofing.**—Asphalt Ready Roofing Co., 136 Water St., New York.

A small 24-page pamphlet telling of the well known Protection Brand of roofing; the ready roofing is laid without the use of nails, nor does it need to be painted nor surfaced after it is laid. The roofing has a 6 in. patented lap, which makes it water tight, and when you have laid it, the job is done.

No. 0662. **Reinforced Concrete.**—W. W. Conard, 829 Swede St., Norristown, Pa.

A 32-page book on the Conard system of reinforced concrete, describing the distinguishing features of this system, and giving tables for designing structural members. The tables are explained and the formulas used are discussed. The reinforcement used is structural steel shapes. Pamphlet of interest to concrete engineers.

No. 0663. **Kennon's Teredo Proof Paint.** The Teredo Proof Paint Co., 17 Battery Place, New York.

A neatly printed 16-page catalog telling of the use of this paint in preserving timber from the teredo, and the hulls of vessels and dredges, and also of the use of this paint for tie and timber preservation from decay. The method of applying it is described. A number of testimonial letters are printed.

No. 0664. **Gibson Oat Crusher.**—Chase & Farnworth, 42 Lexington Ave., New York.

A 32-page booklet given over to describing the use of a machine for crushing oats and corn to be fed to horses. The crushing allows the horse to digest his food rapidly and completely, obtaining nutriment from all he eats. This company has other economical contrivances for feeding and caring for horses.

No. 0665. **Painting Machines.**—J. A. del Solar, 108 Fulton St., New York.

The use of painting and whitewashing machines are described and illustrated. The machines are operated by compressed air, and can be used for lead and oil paints, universal or oxide or cold water paints and whitewash.

No. 0666. **Waterproofing and Sand Blast Finishing.**—National Waterproofing and Cleaning Co., 42 E. 23rd. St.

A 15-page pamphlet devoted to waterproofing and the cleaning of buildings by sand blasting, according to the Farnham patents. Stone, concrete or brick are waterproofed with this process.

No. 0667. **Hand Sweeper.**—Jas. S. Barron, Franklin St. and West Broadway, New York.

Some new circulars showing the improvement in street sweeping made by the introduction of the Peerless Hand Sweeper.

No. 0668. **A New Tarvia Treatment.**—Barrett Manufacturing Co., New York, N. Y.

This 24-page pamphlet explains the new Tarvia treatment for roads by which the material is applied without heating, thus reducing the cost one-half as compared with former methods. Statements of experience with a number of Tarvia treated roads are given The pamphlet is worth reading.

No. 0669.. **Hydrated Lime Machinery.**—The Kritzer Co., Chicago, Ill.

This 12-page pamphlet explains the character and method of manufacture of hydrated lime and tells of its merits and utility for various purposes. The Kritzer machinery for manufacturing hydrated lime is then described and its advantages explained. The company designs, builds and equips complete lime hydrating plants.

No. 0670. **Steel Sheet Piling.** — Carnegie Steel Co., Pittsburg, Pa.

This pamphlet gives diagrams and dimensions of standard U. S. Steel Sheet Piling and Friestedt Interlocking Channel Bar Piling and shows a large number of handsome half-tone views of construction work in which these piles have been used.

Personals.

Mr. M. P. Mitchell has been appointed Borough Engineer of Dunmore, Pa.

Mr. Edward P. Boyd has been appointed Superintendent of Construction of the new U. S. Post Office to be erected at Flint, Mich.

General Contracting & Engineering Co., of New York City, will, on or about May 1, locate in their new offices in the Hudson Terminal, 50 Church St., New York.

Mr. J. B. Shaw of Atlanta, Ga., has been appointed Chief Engineer of the Camilla & Newton Ry. Co., which proposes to build a railway from Fort Gaines to Camilla, Ga.

Mr. Arthur H. Johnson, formerly a special engineer for the Erie R. R., has been appointed Chief Signal Superintendent of the London & Southwestern R. R. of England.

Mr. William V. Barnes, heretofore a leveler to the Board of Estimate and Apportionment of New York City, has been promoted to the position of Transitman and Computer.

Mr. J. T. Richards has opened offices in the Chamber of Commerce Bldg., Chicago, Ill., where he will engage in a consulting engineering practice, making a specialty of reinforced concrete construction.

Mr. F. T. Myers, heretofore Division Engineer of the Mississippi Central R. R., with headquarters at Brookhaven, Miss., has been promoted to the position of Chief Engineer of the above road.

At the last annual meeting of the Civil Engineers' Club of Cleveland, the following officers were elected: President, Mr. Willard B. Beahan; Vice President, Robert Hoffman,; Treasurer, Mr. John H. Fox; Secretary, Mr. Joseph C. Beardsley.

Mr. R. L. Donald, formerly engineer at Portland, Ore., for William S. Barstow & Co., has severed his connection with that firm, and has opened an office in the Failing Bldg., Portland, where he will engage in a general engineering practice.

Capt. Frederick W. Alstaetter, Corps of Engineers, U. S. Army, has been ordered to Wheeling, W. Va., to relieve Capt. Frank C. Boggs of the work and duties in his charge. The latter has been directed to report to Lt. Col. Harry F. Hodges, of the Isthmian Canal Commission, for duty.

Mr. W. S. Turner, C. E., has been placed in charge of the Portland, Ore., office of the engineering firm of William S. Barstow & Co. He will have supervision of the construction of the Hillsboro Branch of the Oregon Electric Ry., and of other work that Barstow & Co. may have in the state of Oregon.

At the regular meeting of the Western Society of Engineers, held April 1, at the Society Rooms, Mr. W. M. Torrance presented a paper on "Reinforced Concrete Structures in Hudson River Tunnel Work." The paper was illustrated by lantern slide views.

Mr. R. H. Pembroke, heretofore Engineer of Maintenance of Way of the Coal & Coke Ry., with headquarters at Gassaway, W. Va., has been promoted to the position of Chief Engineer of the above road. Mr. J. P. Keeley succeeds Mr. Pembroke as Engineer of Maintenance of Way.

Mr. R. S. Stangland has been placed in charge of Muralt & Co.'s construction office at New Fort Lyon, Colo., and will superintend the erection of the complete lighting, heating and power plant which his firm is building for the United States Government at the New Fort Lyon Naval Hospital.

The Contracting Engineering Co., of Tacoma, Wash., and Portland, Ore., has been reorganized and its name changed to the Hurley-Mason Co. The change was made on account of the confusion caused by the similarity of the former name of the company with that of several others, and the necessity for increasing the capital on account of the rapid growth of business. The same organization will continue the management of the Hurley-Mason Co. and present contracts will be carried out under the new name.

Mr. Thomas Robins, founder of the Robins Conveying Belt Co., and President of that concern until March, 1907, when its management passed into other hands, has assumed the General Management of the Robins New Conveyor Co., recently incorporated. The Engineering Department of the new company will be in charge of C. Kemble Baldwin as Chief Engineer. Mr. Baldwin served for over seven years in the same capacity with the Robins Conveying Belt Co. The offices of the company are at 38 Wall St., New York City, and 1240 Old Colony Bldg., Chicago, Ill.

ENGINEERING-CONTRACTING

A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750

NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt

BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3.00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:
The Criminality of Incompetence....219
The Engineering and Commercial Elements Should be Separated....219
CONCRETE SECTION:
Method and Cost of Constructing a Concrete Reservoir, City Park, Pomona, Cal.......................220
Comparative Costs of Mixing Concrete by Hand and by Machine, and Miscellaneous Data on Concrete and Mortar 221
Letters to the Editors: Cost of Constructing a Reinforced Concrete Culvert 221
EARTH AND ROCK SECTION:
A New Style Steam Shovel and the Cost of Excavating a Cellar with It.222
Methods and Cost of Excavating Holes with Explosives.............223
A Test of a Hammer Drill...........223
GENERAL ARTICLES:
Twelve Additional Letters Commending the American Society of Engineering Contractors................224
The Itemized Cost of the Northern Pacific Railway System as Estimated by Its Chief Engineer...........226
Methods and Cost of Constructing a Brick and Steel Wire-Glass Plant at Greensburg, Pa...................228
Cleaning Steel Work by Sand Blast and Painting by Compressed Air...230
METHODS AND COSTS:
Concrete Posts for Marking Corners—Restoring Flooded Machinery to Operation—Cost of Gold-Gravel Mining 225
CATALOGUES WORTH HAVING 230

The Criminality of Incompetence.

As the average man reasons incompetence is far less culpable than carelessness. This is sound reasoning so far as it goes. The competent builder who through mere carelessness allows disaster to occur deserves condemnation to the utmost. On the other hand the incompetent builder who through his ignorance brings on disaster also deserves condemnation for another reason. In this connection the following extract from the charge of a Pennsylvania court in the case of a reinforced concrete building contractor whose work collapsed and killed two workmen is of interest:

"The question is whether the death of these men was due to the gross carelessness or the utter incompetency of the defendants. In either case they were culpable. Houses are not built to fall down immediately. Were these men too ignorant to take up their business of reinforced concrete construction? If they were, it is a case of malpractice. Nobody has a right to hold himself out as qualified to do a thing unless he is able to do it. If these men didn't know enough to be in the concrete business, it was an impudent assumption on their part to risk the lives of men in the erection of this building. Or if it was stinginess which led them to remove the supports of the concrete too soon so that they could use these supports at another place and thereby save some money, they were equally culpable. If the removal of the supports was a mistake of judgment to such a degree as showed that they ought not to be in the business, they are just as guilty. Nobody out of ignorance has the right to risk the lives of other men."

The Engineering and Commercial Elements Should Be Separated.

We quote the title to these remarks because it expresses the burden of argument in several recent papers discussing reinforced concrete. Its contention is not new in engineering history. It is older by far than is reinforced concrete. Among other places it will be found in a great variety of phrasing in the steel bridge literature of say 20 years ago. Then engineers were deploring the practice which bridge works had of drumming up bridge jobs on designs of their own which were generally prepared free of charge and which, moreover, were often proprietary. The practice had many possibilities for viciousness and they were not infrequently taken advantage of. The conditions today in some classes of reinforced concrete construction are not unlike the conditions in certain lines of steel bridge work 20 years ago. Their improvement in so far as they are bad will follow along the same lines.

In one of the papers referred to above it is asserted that the design and supervision of reinforced concrete work should be placed only in the hands of competent independent engineers. The same action was urged in steel bridge practice during the period mentioned above. It was not taken, however. Instead the bridge buyer appointed his own engineer to inspect and check up the designing and other work of the bridge manufacturer. This is the practice today in the great bulk of all steel bridge work. The bridge manufacturer is allowed to work out his own designs conforming to general rules and restrictions laid down by the purchaser's engineer and subject to the purchaser's engineer's inspection and revision. In this way the manufacturer's knowledge of the effect of design on shop and erection costs is taken advantage of without sacrificing the owner's interests in any particular.

In reinforced concrete work the effect of design on construction costs is even greater than it is in steel bridge work. A designer unfamiliar with practical construction methods in say reinforced concrete building work can make a structure cost from 10 to 20 per cent more than it need cost and not gain a cent's worth of increased stability or strength. In fact, no designer in reinforced concrete can be a really good designer without a profound knowledge of methods and cost of doing reinforced concrete work. It is in the possession of this knowledge that the actual builder of reinforced concrete buildings can be of immense service in the labor of designing. It will be better for the building owner to take advantage of this service than to cast it aside because it may involve the risk that may follow from not having the engineering and the commercial elements separated. He can do it and can reduce the risks to a very small amount by doing as the purchaser of steel bridges does—by independent engineering inspection and supervision of the builder's designs and methods of construction.

The suppression of dust on macadam roads by surface treatment with coal tar preparation and asphaltic oils has been tried with much success on the South Parks of Chicago, Ill. The cost has been from 5½ to 6½ cts. per square yard for the first treatment, which will last from one to two years according to the amount of use. The method of application is to spread the preparation hot, about ¾ gallon per square yard, with a layer of limestone chips over it while still soft, and roll thoroughly.

The Interstate Commerce Commission in a special report on the intercorporate relationship of railways shows that on June 30, 1906, out of over $18,000,000,000 of outstanding railway securities $5,300,000,000 is held by railway corporations, leaving outstanding in the hands of the public about $7,800,000,000 of funded debt and $4,700,000,000 of stock.

In a special message vetoing a bill for the construction of a dam by the Rainy River Improvement Co., President Roosevelt warns Congress that there are pending in this session bills which propose to give away without price, steam rights capable of developing 1,300,000 H. P., whose production would cost annually 25,000,000 tons of coal.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Method and Cost of Constructing a Concrete Reservoir, City Park, Pomona, Cal.

BY CHARLES KIRBY FOX, C. E.

The concrete reservoir herein described was erected in the summer of 1904 on Point Lookout, Ganesha Park, Pomona, Cal. It was designed by Mr. Geo. P. Robinson, City Engineer, and Mr. Albert Simmons had the contract. The writer was in direct charge of construction.

The reservoir is oval in form (Fig. 1), being 77.7 ft. by 40.7 ft. over all. It is 12 ft. deep and the floor has a slight slope to the sluice box. Iron ladders are placed in each of the quarter points. The inlet and overflow pipes are near the top of the walls; the discharge pipe is 12 ins. above the botom of the reservoir and the sluice pipe is set in a bowl 3 ft. in diameter and 4 ins. deep. It is the lowest part of the reservoir.

The walls (Fig. 2) are 12 ft. high. They were designed to be 6 ins. thick at the top and 15 ins. thick at the bottom and to be connected with the bottom of the reservoir with a 12-in. radius. The bottom is 4 ins. thick. Before the walls were started it was decided to add a 6 x 30 in. ring to the outside of the top, making the top 12 ins. wide. The joint connecting the walls with the bottom was put in about 12 ins. from the inside edge of the radius.

Around the sluices and inlet and outlet pipes a larger mass of concrete was used. The finish was ½-in. thick and was water proofed.

The contract price of the reservoir was	$1,625.00
Extra concrete in ring, 8.3 cu. yds.	60.90
Extra valve, screws, etc.	16.00
	$1,701.90
Include valve box changed	$ 25.00
Cost of reservoir	1,726.90

Excavation.—The greater part of the excavation of the oval, about 77 x 40 ft., and the tunnel was done by the city by force account. I have no records of the costs of this part of the work. The contractor trimmed down the sides and bottom of the reservoir, in all about 5,000 ft., at a cost of $71.60, or 1½ cts. per sq. ft.

Pipes, Valves, Etc.—The pipes, valves, etc., as provided in the specifications cost $455.52 and the extra valve sets installed cost $16. The laying of the pipe cost $9.70. The tunnel excavation to get down to grade cost $52.38, making a total of $533.60. This includes 5 6-in. Ludlow valves, 270 lin. ft. of heavy 6-in. cast iron pipe and 80 ft. of 6-in. vitrified pipe, all installed.

Cleaning Up.—The contractor mixed the concrete for the walls on the floor of the reservoir and to clean out his old concrete cost him $22.25. The final clean up cost him $7.00, making a total cost for cleaning up of $29.25.

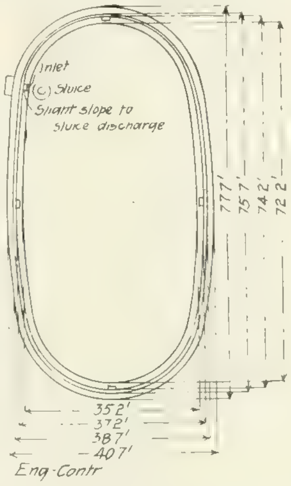


Fig. 1—General Plan of Reservoir.

Concrete.—The concrete was specified to be 1 part cement, 2 parts sand and 4 parts gravel (pea size to 2-in. ring). As put in, a cement barrel was filled and emptied six times with the pin run of sand and gravel and four sacks of cement (1 bbl.) were emptied on top of it; it was then turned wet. The costs per cu. yd. were:

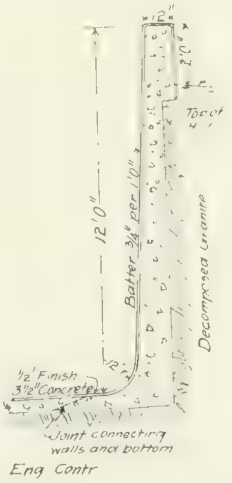


Fig. 2—Cross-section of Wall

	Per cu yd.
Labor	$1.09
Cement, 1.08 bbl. at $3, delivered	3.23
Sand and gravel at $1	0.93
Water (had to be pumped)	0.34
Forms, labor and lumber	0.76
Total	$6.35

The wages paid labor were $1.75 and $2 per day, foreman mason $4 per day. Carpenters were paid 43 cts. per hour and lumber cost $33 per M ft. B. M. A 9-hour day was worked.

Finish.—The ½-in. finish was specified to be 1-1, but that did not work well, so we increased the amount of sand. It was water proofed. It was mixed very thoroughly with 35 lbs. alum at 6 cts. per lb., and then the water, containing 35 lbs. good potash soap per cubic yards of mortar was added. The finish cost:

	Per. cu. yd.
Materials	$14.45
Labor, mixing and applying	11.90
Total	$26.35

On the finishing there were two masons at $4 plastering and enough laborers to keep them supplied with mortar. The completed floor cost 9 cts. per sq. ft.

Summary of costs:

Cement at $3 per barrel	$ 481.50
Sand at $1 per cu. yd.	113.30
Soap and alum at 6 cts. per lb.	21.00
Water	43.00
Timber	30.00
Labor and superintendence	361.35
Pipe laying (contract price)	533.60
Total	$1,583.75

The reservoir has now been in use 3½ years and has given excellent satisfaction. Only a few hair cracks have appeared on the surface and none of the plaster has scaled off.

---

*Pomona, Cal.

From 12 to 15 per cent of the entire locomotive fuel supply of the Northern Railway of France consists of briquettes. The briquettes are cubical in form, weigh about 22 lbs. each and contain from 18 to 22 per cent of volatile matter. They are used for kindling the fire and getting up steam before the engine goes on duty, and also when it is required that the engine shall put forth its maximum effort. The cost of the briquettes during the past three years has ranged from $3.03 to $4.25 per metric ton of 2,204 lbs.

An important patent was issued March 17, 1908, patent number 882,520, to Frank B. Gilbreth, and is now owned by the Corrugated Concrete Pile Co. of America. There are 29 claims, the last one being: "29. In a pile sinking apparatus, the combination with jetting means and pile forcing means, of means for interposing a cushioning of loose material between the pile and the said forcing means."

Montreal, Que., is to spend $2,500,000 in putting its streets in repair this summer.

Comparative Costs of Mixing Concrete by Hand and by Machine, and Miscellaneous Data on Concrete and Mortar.

The following data on concrete and mortar have been compiled by Mr. Clarence Mayer* from records kept in constructing telephone conduit and other concrete work. They are particularly interesting because of the large number of jobs from which they are averaged.

Comparison of Hand and Machine Mixing.—The data given in Tables I and II were collected on conduit work, where 6-duct or 8-duct conduit was being installed and where the mixing gang worked all day. They show the cost of mixing by several different foremen on five or six jobs each. The data were secured without the knowledge of the foremen so that no attempt would be made to accomplish more than average work. The days on which the data were taken were selected with regard to no conditions other than that concrete be mixed all day and the weather be fair. The cost of moving mixing boards and mixer and time consumed in getting tools, etc,. when starting work are included in the costs, but supervision and expenses are not included. The advantage of mixing by machine when the work requires the mixing of more than a small quantity of concrete is clearly shown by these data.

TABLE I—COST OF MIXING CONCRETE BY MACHINE

Foreman	No. of Mixings	Prop. of Mix. Cu. ft.	No. cu. yds. mixed	No. men worked	No. hrs. worked	Av. No. mixings per hr.	Av. time to mix 1 cu. yd. Mins.	Av. cost per cu. yd.
A	1,586	¾—3—6	380.87	5	120	13	19	$0.385
B	960	¾—3—6	230.54	6	61	16	16	0.382
C	528	¾—3—6	126.80	5	27	19½	13	0.260
D	1,140	¾—3—6	273.77	5	79	14½	17	0.353
E	1,804	¾—3—6	433.23	7	75	24	10	0.289
Totals and average	6,018	....	1445.21	5 3/5	362	17	15	0.339

Wages, engineer $3, laborers $2 for 9 hours.

TABLE II—COST OF MIXING CONCRETE BY HAND.

Foreman	No. of Mixings	Prop. of Mix. Cu. ft.	No. cu. yds. mixed	No. men worked	No. hrs. worked	Av. No. mixings per hr.	Av. time to mix 1 cu. yd. Mins.	Av. cost per cu. yd.
A	135	9—36—72	389.04	5	172	0.78	27	$0.491
B	211	3—12—24	202.68	4	133	1.59	39	0.583
C	604	3—12—24	580.20	5	283	2.13	29	0.542
D	161	6—24—48	309.31	6	118	1.36	23	0.510
Ave. and totals	1,111	....	1,481.23	5	706	1.57	29	0.530

Average Wheelbarrow Loads.—The following data on average wheelbarrow load are based on actual tests made on numerous jobs without knowledge of either foremen or laborers. They show the average load wheeled by the average laborer and are as follows:

Items.	Cu. Ft.
Measured capacity of wheelbarrow....	3
Average load, sand, gravel or stone...	2¼ to 2½
Average load, mixed concrete...	1½ to 1¾

Shrinkage of Mortar and Concrete.—The following data on shrinkage of mortar and concrete are averaged from records kept on many jobs. For concrete they are based on washed gravel aggregates. A certain percentage of this shrinkage can be charged to waste resulting from mixing on paved streets, rough boards, windy days, etc. The figures are for the volume of mixture required for 1 cu. yd. in place:

	Cu. Ft.
1 cu. yd., 3 to 1 mixture............	33.76
1 cu. yd., 1-4-8 concrete..............	40.60
1 cu. yd, 1-3-8 concrete..............	36.63

Quantity and Cost of Mortar per 1,000 Bricks.—The quantity of mortar required per 1,000 bricks is 0.9 cu. yd. This quantity is based on building vaults of sewer brick averaging in size 8 x 23¾ x 2½ ins., the wall of the vault being two bricks thick and every 6th course being laid as headers and the horizontal mortar joints being ½ in. and the vertical mortar joints being ⅜ in. thick. Some of the mortar is lost over the brick of the wall, some is lost in handling and some is used in incidental work such as cementing in a sewer trap. Where this figure has been used in estimating, the variation in quantity between the estimated and actual quantity used has been less than 2 cu. ft. per vault. With cement costing 43¼ cts. per bag and sand costing $1.90 delivered on the work the cost of mortar per 1,000 brick is as follows:

Mortar 1 cement 2 sand.............	$5.81
Mortar 1 cement 3 sand.............	4.88

The U. S. Forest Service now has administration over more than 164,000,000 acres of land. This is slightly more than one-fifth of the country's total forested area; the remainder is in the hands of private owners. Nearly all the timberland of the unappropriated public domain is now in the National Forests.

LETTERS TO THE EDITORS.

Cost of Constructing a Reinforced Concrete Culvert.

Sirs: In your issue of February 12, 1908, under the heading "Method and Cost of Constructing a Reinforced Concrete Culvert," we are unable to figure out the cost of construction of this culvert from the data given to agree with that of County Surveyor Wm. Kohlman, as stated in the article.

We have checked volume of masonry, which seems to be correct. We note the mixture 2-2-6, which according to our experience gives aggregates about as follows: Cement 2.06 bbls. per cu. yd., sand 0.31 cu. yd. per cu. yd. and crushed stone of size noted in article 0.98 cu. yd. per cu. yd., being same as given in Gilbreth's "Field System." This would make the cost for 91 cu. yds. of concrete (assuming there was no floating or finishing after forms were removed) as follows:

91 cu. yds. at 2.06 bbls. cement = 187.46 bbls., at $2..............	$ 374.92
91 cu. yds. at 0.31 cu. yd. sand = 28.21 cu. yds. at 60c.............	16.92
91 cu. yds. at 0.98 cu. yd. chats = 89.18 cu. yds. at 80c.............	71.34
Reinforcem't (as per your article)	114.00
Lumber (as per your article)......	62.00
Labor (as per your article).......	498.00
Total	$1,137.18

Making a total cost per cubic yard of about $12.50. We believe that a saving of $1.20 per cubic yard could have been made by using a 1-2-4 mixture and just as satisfactory results attained. Will you kindly advise us if there was not a mistake in the figures in the statement. Yours very truly,

LEFEVRE & EDWARDS.
By J. T. Edwards.

Cumberland, Md., Feb. 17, 1908.

[A copy of this letter was sent to Mr. Kohlman for reply and we print his answer below.—Editors.]

Sirs: The gentlemen are right. I have made a clerical error, as follows: It should read 98 bbls. of cement at $2 per bbl., $196. The tailings or chats cost 80 cts. per load of 1½ cu. yds. for hauling, which would make their cost $0.533 per cu. yd. The article says the chats contain more or less sand and there were but 10 cu. yds. used. We also placed a good many limestone rocks (in layers) in the footings and abutments, up to the spring line of arch. These rocks were found on the ground, having been placed in stream by the road overseer for a road crossing.

Yours Truly,
WM. KOHLMAN.

Carthage, Mo., Feb. 21, 1908.

Canada has spent $91,000,000 in canal construction, and is now expending $1,730,000 annually for further improvements. Last year over 51,000,000 tons of freight were transported through the canals.

---

*Formerly Cost Statistician and Facilities Engineer, Chicago Telephone Co. Author of "Telephone Construction—Methods and Cost."

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

A New Style Steam Shovel and the Cost of Excavating a Cellar with It.

In digging the foundation and cellar of the new Foreman-Ford building, in Minneapolis, Minn., the contractor, The John Wunder Co., used a steam shovel manufactured by the Browning Engineering Co., of Cleveland, Ohio.

This steam shovel is a radical departure from any other style, being simply a locomotive crane with a dipper and dipper arm attached to the boom. These shovels although they are new in cellar excavation, have been used for other work very successfully. Fig. 1 shows the machine, weighing about 25 tons, with a 1 yd. dipper, at work on the cellar excavation in Minneapolis, while Fig. 2 shows a smaller size machine at work excavating clay in a brick yard in New Jersey; the car being loaded is 13 ft. higher than the shovel.

The shovel, as shown in Fig. 1, loaded on a crib of timbers, the timbers being put in place and taken away by the machine.

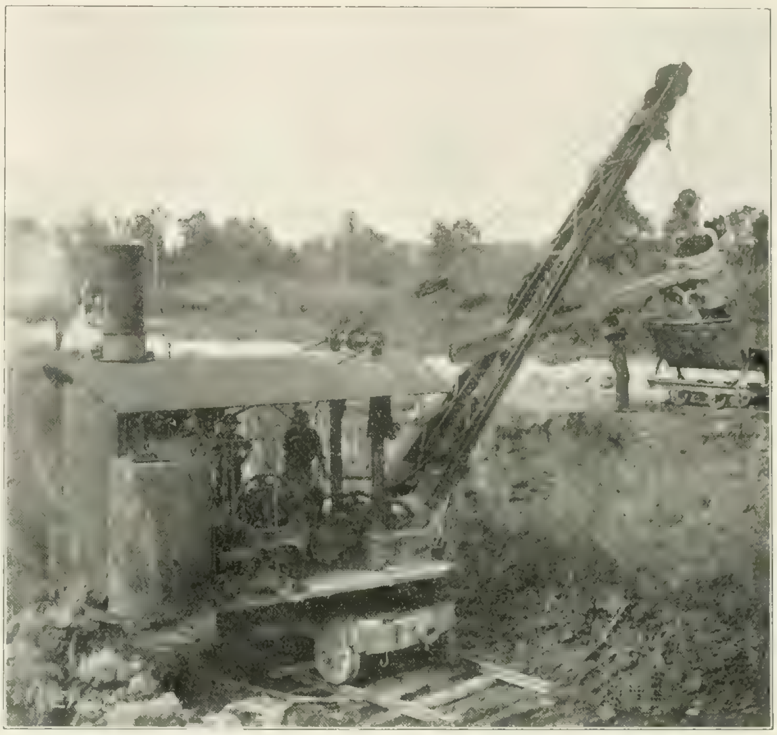


Fig. 2—Steam Shovel Excavating Clay for a Brick Plant.

One advantage of this shovel is that the boom angle is variable, being raised and lowered by a lever convenient to the engineer's hand. The dipper arm works on a shipper-shaft through the boom. This allows the dipper to dig both low down under the boom, and also high up on a bank; and, in digging this cellar, this ar- wagons, at first dumping the dirt directly into the wagon, but afterwards into a hopper, under which the wagons were driven and loaded. This hopper was roughly made, having no bottom, but it saved the wagon from being hit by the dipper, and also prevented dirt from being spilled off the wagon when loading. (For a description of a hopper with bottom used in loading wagons, see ENGINEERING CONTRACTING, Dec. 11, 1907, page 331.) The hopper was picked up and moved about as needed by the crane.

The machine started at the street and dug its way down an incline which was left so the machine could come out upon it. It is possible, though, for the shovel to excavate this earth, and be taken out rangement allowed of digging within a few inches of an adjoining building.

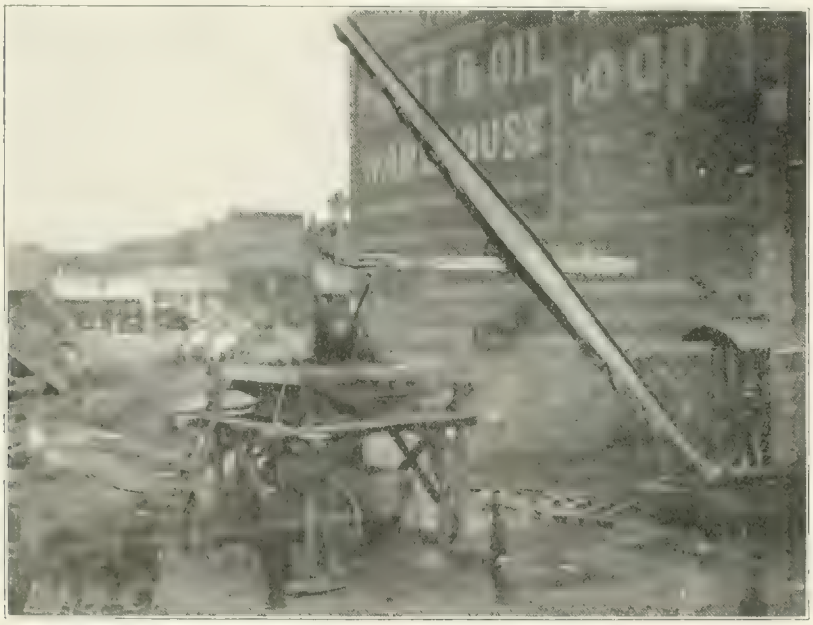


Fig. 1.—Steam Shovel at Work in Cellar Excavation.

Two men only are needed to operate this shovel, the engineer and fireman; the latter both fires and trips the dipper door. The cost of operating the shovel per day is as follows:

Engineer, 10 hours	$ 3.00
Fireman, 10 hours	2.00
Coal, ½ ton	2.00
Oil and waste	.30
Depreciation and repairs, estimated 20 per cent per annum	4.00
Interest on investment	1.20
Total operating cost per day	$12.50

Although the manufacturers claim that this shovel can excavate 800 cu. yds. per day, yet the material in this cellar was very hard, being stiff yellow clay, and part of the time being frozen from 6 to 10 ins., so that the shovel only averaged 400 cu. yds. per day; a further reason for this small output being a lack of wagons. Nevertheless the cost of loading the wagons was only 3 cts. per cu. yd. and including taking the shovel to another job 3 miles away the cost was only 5 cts per cu. yd.

The Empire Engineering Co., of Montreal, Canada, moved one of these shovels over an ordinary wagon road a distance of two miles, under its own steam. Two sets of rails were used, the machine picking up the set in the rear and swinging them around in the front. The cost of moving was:

One engineer, 3 days	$ 9.00
3 laborers, 3 days at $1.60	14.40
Fuel	4.00
Oil and waste	.60
Team hauling water, 3 days	10.50
Total	$38.50

This makes a cost of $19.25 per mile, which is very cheap. The fact that the crane revolves cheapens the moving as well as much other work it does. In moving ahead in the cut the track is moved in the same manner. Then, too, when the machine has cut to the end of a row, it does not have to be turned like a shovel, but it revolves on its circle, and immediately begins digging.

In cellar excavating, after the earth is excavated, the dipper arm can be taken off, and the machine used as a crane for hoisting and erecting, or for pile driving, and for other purposes.

It can be equipped with a clam-shell bucket, and used for unloading sand and stone from cars, and also for unloading coal.

With the dipper, trenches can be dug for sewers and water pipes, but to do this the machine must straddle the trench. With an orange peel bucket it can still dig ditches, but the machine can travel on one side of the trench. It can also be used to drive sheet piles for shoring, likewise for lowering pipe and other materials into the trench.

Another novel use of this machine is to clean ditches in a railroad cut. A long dipper arm is used as in trench work. The shovel is put on a flat car on a track. The whole train being made up of these cars enables the shovel to move along on the cars excavating the ditches on each side of the track. When not being used for this work, it is unloaded from the car and used for handling coal, ashes or other materials.

The total excavation on the Chagres Division of the Panama Canal during February was 200,145 cu. yds., about 25 per cent of which was rock, an average of 803 cu. yds. per shovel per day. This was accomplished with three 45-ton, two 60-ton, and six 70-ton shovels, and gives an average excavation per day, per shovel-ton, of 13.08 cu. yds.

A resolution is now before the City Council of Buffalo, N. Y., for the creation of a board of paving commissioners to prepare the specifications for all pavements having a concrete base. The resolution provides that the board is to consist of the Commissioner of Public Works, the City Chemist and a contractor informed on concrete construction.

Methods and Cost of Excavating Holes with Explosives.

In our issue of Jan. 1, 1908, we published the cost of digging holes for tree and shrub planting. These holes were dug by hand with the pick and shovel, which has been the usual method. Such holes are always expensive to dig and yhen 3 ft. or more in diameter and 2 ft. or more deep, cost 50 cts. and up per hole.

Each year engineers are finding that they have more and more to do with tree planting. Railroad companies are planting trees for tie and timber supplies, besides using them to adorn their station grounds. Around reservoirs and filter plants they are likewise being used. They are also planted as a protection to levees and dikes.

It is for these reasons that we give space to the method of "blowing a hole" used by Mr. H. B. Nellerton, Special Agent of the Long Island R. R. Co., in planting a large number of trees on Long Island.

A hole was churned in the ground where the tree was to be planted, with a churn drill, at an angle with the surface of 35° to 40°. The hole was made about 2 ft. deep, and loaded with a half stick of 40 per cent dynamite (¼ lb.) and shot. This blew out of the ground a hole about 3 ft. in diameter and about 2 ft. deep, making a hole the shape of a cone. The soil left in the bottom of the hole was well pulverized, admitting of the tree being planted without further preparation.

One man accustomed to handling explosives, with a helper, blew out on an average 250 holes per day, working 10 hrs. The dynamiter prepared the charges and loaded the holes, tamping them but little, while the helper churned the holes and assisted in other work.

The cost of blowing 250 holes was:

1 man	$ 3.50
1 man	1.50
500 ft. fuse at 45 cts. per 100 ft.	2.25
250 caps at 75 cts. per 100	1.87
63 lbs. of dynamite at 15 cts.	9.45
Total	$18.57

This gives a cost of 7.4 cts. per hole. From each hole about 4.7 cu. ft. of earth was excavated, being equal to .17 cu. yds. At the above cost this makes 43 cts. per cu. yd. In such a hole trees as large as 4 ins. can usually be planted.

With a deeper hole and a larger charge of explosive larger holes could no doubt be blown out. It would also be possible to use either black powder or Judson instead of dynamite, and the work might be cheapened by the use of either of them.

The railway merger in Mexico has been accomplished under the title of the National Railways of Mexico, with an initial share capital of $230,000,000 gold. It includes the two leading trunk lines, the Mexican Central and the National, and a controlling interest is held by the government.

A Test of a Hammer Drill.

We are frequently asked as to the work that a hammer or plug drill will do. We give an account of a test made recently at Cobalt, Ont., with a Sullivan air hammer drill D 21.

The hole was a dry back hole, in a drift, at a slope of about 75, and was in hard conglomerate rock all the way. Drill was set up on a tie in the track. The time taken to set up, after connections were made, was 20 secs. The time consumed from the starting of drilling till the test was completed was 18 mins. The length of hole drilled was 5 ft. 4½ ins.

Five pieces of drill steel were used and the time for each was as follows:

	Min.	Min.
1st drill	0— 4	4
2nd drill	4— 7	3
3rd drill	7—11	4
4th drill	11—15	4
5th drill	15—18	3
Total		18

The time consumed in changing drills is included in above and was from 15 to 20 secs. for each change. The cutting fell from the hole in a steady stream and the air in the vicinity of the drill was not nearly so dusty as would have been the case with an ordinary percussion drill.

The city of Logansport, Ind., according to press reports, has taken a somewhat unique method of paying a contractor for constructing a sewer. Some years ago a contract was let for building a sewer in the west side of the city. The contract price was about $278,000, of which $57,499 was assessed against the city, and the balance against abutting property holders. After the contract had been let it was found that the city had exceeded the 2 per cent limit of indebtedness, and because of this some of the taxpayers enjoined the city from paying its share of the cost of the sewer. The injunction was made permanent. At the last session of the Indiana Legislature a bill was passed that specifically met conditions as they existed in Logansport. Through the provisions of this law the Board of Public Works has been enabled to lease the sewer from the contractor, agreeing to pay him $3,722.25 semi-annually, until he has been paid $57,499. The terms of the lease call for 10 years, but the city can at any time pay the balance on the total and assume full possession of the sewer.

The total amount of excavation in the Chagres Division of the Panama Canal has been reduced more than 1,500,000 cu. yds. from the original estimate, by two changes in the alignment of the axis of the Canal prism. One of these changes, made and approved in November, 1907, caused a reduction of 179,000 cu. yds., and the second, made and approved recently, caused a still further reduction of 1,350,050 cu. yds.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Twelve Additional Letters Commending the American Society of Engineering Contractors.

In answer to editorials and invitations extended to engineers and contractors to apply for membership in this proposed society, Mr. Gillette has received scores of letters advocating the formation of such an organization.

Applications are coming in rapidly, the total number received being about 900. It would seem, therefore, that the permanent organization should soon be effected. An application blank can be found on page 14 of the advertising section. In our last issue we printed 12 letters commending the formation of this society; 12 additional letters, lately received, follow:

Sir:—I am desirous of becoming a charter member of the American Society of Engineering-Contractors, provided the dues and conditions of membership shall prove satisfactory to me when they shall be decided upon.

Very truly yours,
Layton F. Smith, C. E.,
Resident Manager Trussed Concrete Steel Co., Baltimore, Md.

Sir:—Will you kindly let me hear from you in accordance with accompanying blank?

Yours truly,
J. S. Caldwell,
General Contractor,
Trenton, N. J.

Sir:—I am enclosing herewith my tentative application for membership in the A. S. E. C.

I am the engineer member of a syndicate composing several companies, of which the above is one, engaged in railroad, irrigation and other work. Though most of our construction is let outside of the firm, the overseeing, etc., devolves upon me and I think I am fairly eligible for your society.

My previous engineering experience has been mainly along the above lines, as well as mining, prospecting and surveying.

I am leaving town shortly, so kindly address my residence, 112 Bedford road, from where letters will be forwarded.

Hoping that the conditions of membership prove acceptable and wishing the society every success, I am,

Very truly yours,
A. B. Bowes,
Lindsay, Bobcaygeon & Pontypool Ry.,
Toronto, Canada.

Sir:—I am interested in the new society of E.-C. which you are engaged in forming and hand you herewith my application for membership subject to conditions in blank form.

Yours truly,
M. W. Smith, C. E.,
505 E. 5th St.,
Little Rock, Ark.

Sir:—Herewith application of Mr. Burke and myself for membership in the American Society of Engineering Contractors. The organization is along the right lines and should be productive of much good.

Very truly,
L. S. Joseph,
Burke & Joseph,
General Railroad Contractors,
Cape Girardeau, Mo.
Also of Burke Bros. Construction Co. and Missouri Construction Co.

Sir:—I enclose herewith my application for membership in the American Society of Engineering-Contractors. Please keep me advised as to your progress in this matter.

Yours truly,
James H. Bacon,
Harbor Engineer,
Grand Trunk Pacific Ry.,
Prince Rupert, B. C.

Sir:—Please find my application enclosed for charter membership to the American Society of Engineering Contractors. This is a society that I think the contractors of America have long felt the need of and my earnest wish is that your undertaking will be successful to the extreme.

Yours respectfully,
E. Clarence Hingston,
Contractor,
479 Marshall St., Milwaukee.

Sir:—Enclosed find application for membership in your newly organized American Society of Engineering Contractors.

I note with pleasure the class of men who are applying for membership, and trust that the personnel of the society will be maintained to the extent that membership in the same will be an indorsement of one's ability, integrity, etc.

With best wishes for the success of the society, I beg to remain,

Yours sincerely,
A. B. Collins,
Vickery, Foster & Collins,
Consulting and Contracting Engineers,
Denver, Colo.

Sir:—I am enclosing herewith application for charter membership in the American Society of Engineering-Contractors, subject to conditions as stated in application. I am confident that such an organization will prove to be of great value to both engineers and contractors, between whom the best of relations should always exist, to accomplish maximum results at minimum cost. And I wish further to state that Engineering-Contracting is a most welcome weekly visitor and without doubt is filling a niche in the Engineering-Contracting World, supplying a long-felt need.

Sincerely yours,
Chas. W. Quinn, C. E.,
Concrete Inspector, Engr. Const.,
C. S. N. O. & P. R. R.,
Houston Heights, Texas.

Sir:—Am enclosing herewith my application for charter membership in the American Society of Engineering-Contractors as per conditions printed thereon.

Very truly,
G. W. Ely, Jr.,
Resident Engineer, J. G. White & Co.,
Hatfield, Wis.

Sir:—I herewith enclose you application for charter membership in American Society of Engineering-Contractors. I am of the opinion that this society will prove to be highly beneficial to all parties interested.

Yours very truly,
Thos. H. Walker
Gen'l Mgr. Carter Construction Co.,
Cleveland, Ohio.

Sir:—I attach hereto my application for charter membership in the American Society of Engineering-Contractors.

I believe the movement—like a rocker built for two—will fill a long-felt want.

Yours truly,
J. F. Werlich,
1217 George St., Chicago, Ill.
Commonwealth Edison Co.

The chief of the sanitary service at Gaboon, French Africa, has been experimenting with the cactus as a substitute for petroleum for the extermination of mosquitoes in warm climates. The thick, pulpy leaves of the cactus, cut up in pieces, are thrown into water and macerated until a sticky paste is formed. This paste is spread upon the surface of stagnant water, and forms an isolating layer which prevents the larvæ of the mosquitoes from coming to the top to breathe and destroys them through asphyxiation. The mucilaginous cactus paste is said to hold its place indefinitely, lasting weeks, months, or even an entire year; and the period of development of the larvæ being but about a fortnight, it has the most thorough effect.

Concrete is used to a very small extent in Greece, the sidewalks of cities and towns being very generally paved with marble.

Methods and Costs; Some Old; Some New.

Concrete Posts for Marking Corners.—In certain sections of Illinois the surveyors use concrete posts for marking the corners for their surveys. These posts are 30 ins. long, 3½ ins. diameter at the top, and 4¾ ins. at the bottom, with a die mark in its top giving name, address and a cross or cut for the point indicated to mark the corner. The mold or form in which the post is made is of galvanized iron, bent to hold its cylindrical shape, about 1 in. larger in diameter than the desired size of the post. When ready for use it is sprung down to its required dimensions and is held in place by three wire rings, one at either end and one near the middle. These rings are of No. 6 wire, with ends left about 4 ins. long for handles to press down before the cement is put into the mold and also to push up or loosen when the post has set sufficiently to remove from the mold. The concrete for the post is made of 1 part of Portland cement, to 3 parts sand and 3 parts of 1½-in. crushed limestone. The top inch is made of neat cement. For corners where it is desired to build to the line, the form should be made square and have the "corner point" at one corner of the post.

Restoring Flooded Machinery to Operation.—A portion of the electrical equipment of a power plant was submerged by a flood, the water rising to a height of about 12 ft. above the floor, remaining at this level for two days, and then gradually subsiding, taking ten days to reach the floor level. The submerged machinery consisted of a 350 K. W. direct current generator direct connected to a horizontal engine, a 200 K. W. direct current generator also direct connected to a horizontal engine, and 22 motors, ranging in capacity from 1½ to 75 H. P. As the water subsided the engineer made his way about the engine room on a raft and by means of a force pump kept the mud washed from the exposed parts of the machinery. This washing process was continued until the flood water was well below the floor level and the lowest parts of the machines. In the meantime about 2½ ft. of mud which had been left by the flood was removed from around the engines and generators. The generators were then housed in by a double thickness of matched flooring, and steam coils placed along the bottom at each side. Live steam was supplied to these coils day and night for a week, and the generators, still enclosed, were then slowly revolved for a time. After the housings were removed, the generators were cleaned and the brush yokes and studs taken apart and brightened, especial care being taken to touch up all points of electrical contact. In making the first trial of the machines they were brought up to full voltage gradually and the load put on by degrees. As to the motors, the smaller ones were taken apart and baked in one of the houses; while the larger ones were housed in place and treated like the generators. It is stated that neither motors nor generators suffered an increase in maximum heating temperatures or loss of efficiency.

Cost of Gold-Gravel Mining.—The following data on the cost of mining in Alaska have been taken from a U. S. Geological Survey Bulletin prepared by C. W. Purington. The data were compiled from statistics collected in the summer of 1904. The costs include depreciation on plant. In figuring out this depreciation, six years, in general, was taken as the average life of an individual property, and, except in the case of winter drifting operations, 120 days as the working season. In cases where expensive plants have been installed the amortization was calculated separately for each case; in cases of shoveling-in and small mechanical plants, the installation and maintenance cost was taken at an average amount for a group of operations in each district. The cost of fuels available for use in Alaska were about as follows: Bituminous coal at Nome, $17 per ton of 2,000 lbs.; crude oil at Nome, $3 per bbl.; spruce wood, average price in interior, $12 per cord. The scale of wages for laborers ranged from $3.50 to $4 at Juneau, to $10 per day at Fairbanks; the average was probably about $5 per day with board. Foremen at Fairbanks received $14 per day without board. The sections for which the costs were obtained were divided into three provinces as follows: South Coast Province, which includes the Juneau, Porcupine and Sunrise Districts of Alaska; the Interior Province, which includes the Atlin District of British Columbia, the Klondike District of Yukon Territory and the Fortymile, Eagle, Birch Creek, Fairbanks, and Rampart Districts of Alaska; and the Seward Peninsula Province, which includes the Nome, Council and Solomon Districts of Alaska.

The average cost of the gold-gravel mining operations in the Interior Province and the Seward Peninsula Province are shown in the accompanying table. It should be stated that in the costs, lost time, the prices paid for mining property, and the cost of equipment other than that relating to actual mining (i. e., railways, wagon roads, etc.) are not taken into account:

AVERAGE COST OF GOLD GRAVEL MINING OPERATIONS IN NORTHWESTERN AMERICA.

	Interior Province				Seward Peninsula Province.			
	Ave. capacity cu. yds. per 24 hrs.	Thickness of Deposit. Feet.	Thickness of gravel worked Feet.	Cost per cu. yd.	Ave. capacity cu. yd. per 24 hrs.	Thickness of deposit Feet.	Thickness of gravel worked. Feet.	Cost cu. yd.
Hydraulicking, no pumping of water	1,049	37.4	37.4	$0.238	....	.		.....
Hydraulicking with use of hydraulic elevator	..	....			658	12	1	$0.89
Open cut; shoveling into sluice boxes, including stripping top dirt; no pumping	63	8.6	3.5	2.39	145	6.6	5.2	1.87
Open cut; horse scraping	105	20	10*	.60	200	5		46
Open cut; shoveling; wheeling to bucket; cable tram to sluice	162	17.5	4.5	2.14	..			.
Open cut; shoveling into cars; track and incline to sluice	450	14	5	2.43	.	..		.
Open cut; shoveling into buckets or skips; skidding or tramming, and derricking to sluice	233	17	9	1.75	550	15	11	.91
Open cut; shoveling into sluice; tailings by hydraulic lift	184	8	6	1.25	. .	.		
Open cut; steam-shovel excavating; track and incline to sluice	800	22	22	1.46	1,000	30	27	.72
Open cut; steam scraping; generally on stripping work or tailings	92	15	8.7	.49	.....	..	..	....
Dredging	1,062	35	35	.49	700	8	8	.43
Drifting partly frozen or thawed ground requiring timbering	50	.60	4	4.25	80	20	7	4.49
Drifting and thawing solidly frozen ground; little or no timbering	75	26.4	4.4	3.38	20	35	4	3.66
Winter drifting and spring sluicing of dumps	50	26.4	4.4	5.14	83	85	4.3	4.61
Mining or stripping overburden by ground sluicing	150	9	9	.17	173	4	4	.10
Hydraulicking by means of pumped water	830	33	33	.65	250	23	23	.93
Booming with self-dumping water gate	250	7.5	6*	.07	...	..	..	.....

*Muck and top gravel. †Muck or fine silt and ice; from 50 to 75 per cent ice.

The average cost of gold-gravel mining operations in the South Coast Province was as follows:

	Av. capacity cu. yds. per 24 hours....	Thickness of deposit, feet	Thickness of gravel worked. feet........	Cost per cu yd..........
Hydraulicking, no pumping of water	833	30.3	30.3	$0.20
Hydraulicking with use of hydraulic elevator	350	25	25	.31
Open cut; shoveling into sluice boxes, including stripping top dirt; no pumping	54	5.6	3.7	2.01

The Itemized Cost of the Northern Pacific Railway System as Estimated by Its Chief Engineer.

In our issue of July 24, 1907, we gave the itemized cost of 1,000 miles of the C. M. & St. P., as estimated by its chief engineer, and given in the form of testimony in the "South Dakota Rate Case." In this article we give a similar estimate prepared by Mr. W. L. Darling, chief engineer of the N. P. Ry., and introduced as part of his testimony in the "Spokane Rate Case" before the Interstate Commerce Commission a few months ago.

While many of the quantities were guessed at by Mr. Darling, and while no quantities at all are given for many items, but simply lump sum estimates, still these data are worthy of being recorded, if only to indicate the relative cost of different items. Engineering, for example, is estimated at 3 per cent of the total, and this percentage is undoubtedly not far from correct, although the actual amount estimated for engineering is unquestionably very liberal.

The reader should bear in mind that this estimate was prepared for the purpose of proving that the Northern Pacific Ry. is not earning an unreasonable amount of money, considering what the physical value of the property is today. The city of Spokane contends not only that it is discriminated against in the matter of transcontinental freight rates, but that the rates are in themselves too high, and yield an unreasonable profit to the railways. The Northern Pacific and Great Northern Rys. contend that their rates are reasonable and yield only a fair profit; and, in proof, they have submitted estimates of the cost of reproducing their entire systems as they stand today, using what they claim to be current unit prices. Regarding these unit prices, it is only fair to say, that the City of Spokane contends that they are, in nearly every instance, unreasonably high. Mr. Halbert P. Gillette, in behalf of the City of Spokane, testified that much lower unit prices are commonly paid by railways in the northwest. He also criticised the quantities in many instances, claiming that they were mere guesses, and not trustworthy. We shall not go into all the testimony that was offered by both sides in the controversy, further than to put on record an abstract of the testimony of Mr. W. L. Darling, chief engineer of the N. P., and Mr. Hogeland, chief engineer of the G. N.

The mileage of the N. P. is as follows:

	Miles.
Main line, single and second track	2,860.67
Branch lines, main and second track	3,014.24
Spurs, sidings and yard tracks	1,819.88
All tracks, total	7,694.79

Of this track only 112 miles is second track.

Mr. Darling's estimate of the cost was presented in the following form:

Grading and track	$138,745,971
Grade revisions, 1897 to 1901	2,350,600
Turnouts	1,838,750
Permanent bridges	9,950,248
Temporary bridges	4,284,580
Culverts	3,091,000
Wooden bridges filled	4,518,600
Tunnels	3,921,421
Fencing	707,290
Snow fences	537,600
Telegraph	1,443,000
Water supply	1,971,200
Coaling stations	635,900
Wharfs and docks	1,725,000
Stock yards	152,857
Track scales	107,671
Cattle guards	57,195
Round houses, turntables, power houses, etc.	1,680,448
Shop buildings	2,091,650
Miscellaneous buildings	1,578,528
Warehouses	2,886,016
Headquarters building	756,600
Furniture	440,000
Passenger stations	1,102,304
Combination stations	1,408,960
Duluth Union depot	343,300
St. Paul Union depot	159,200
Interlocking	123,555
Block system	44,307
Mile posts and signs	129,584
Ash pits	79,067
Oil and sand houses	120,960
Shop tools and machinery	1,100,000
Kalama ferry and steamer	617,400
Lines in Manitoba	7,000,000
Joint work, Seattle	2,457,000
Total	$200,155,762
Engineering, 3%	6,004,673
Total	$206,160,435
Contingencies, 10%	20,616,043
Total	$226,776,478
Interest during construction—4% for 2½ yrs., 10%	22,677,648
Total	$249,454,126
Freight equipment	30,486,000
Passenger equipment	5,898,000
Power	16,480,200
Floating equipment	497,000
Grand total	$302,815,326

This does not include lands which were estimated to be worth as follows:

Right of way, not including large terminals	$31,889,587
Large terminals	75,000,501
N. P. interest in terminal companies	882,655
Coal properties	50,720,120
Total	$158,492,913
Grand total	$461,308,239

This estimate of the value of lands was not made by Mr. Darling.

In estimating the cost of grading, Mr. Darling stated that an estimate of quantities was made in 1898, and was as follows:

	Total.	Per Mile. (4,419 mi.)
Clearing, acres	15,089	3.4
Grubbing, stations	21,124	4.8
Earth, cu. yds.	88,334,218	20,000
Loose rock, cu. yds.	7,258,532	1,640
Solid rock, cu. yds.	5,164,479	1,170
Riprap, cu. yds.	1,548,911	350

At that time there were 4,419 miles of main track and branches, plus 850 miles of siding and yard tracks, or a total of 5,269 miles of track. In the year 1907, however, there were 1.4605 times as many miles of track. Hence, it is reasonable to suppose that each of the above quantities is 1.46 times larger now than in 1898. But, in addition to this, Mr. Darling claimed that all embankments had been widened from an original 14 ft. to a present 18 ft., and he estimated that all the above quantities (except the clearing and grubbing) should be multiplied by 1.20 to allow for this increase in bank widening. This would make a total increase of 1.20×1.4605 =1.7526. Accordingly, Mr. Darling increased the grading quantities by 75.26% and secured the following quantities, to which he affixed the following unit prices:

22,036 acres clearing at	$80.00	$1,762,880
30,851 stations grubbing at	16.50	590,042
116,110,913 cu. yds. earth at	0.28	32,511,055
38,703,637 cu. yds. hardpan at	0.42	16,255,528
12,721,303 cu. yds. loose rock at	0.50	6,360,651
9,051,266 cu. yds. solid rock at	1.10	9,956,393
2,714,621 cu. yds. riprap at	2.00	5,429,242
Total grading, etc.		$72,865,791

It will be noted that the 1898 estimate of quantities showed the following classification:

Earth	88%
Loose rock	7%
Solid rock	5%

But Mr. Darling claimed that fully one-quarter of this earth (or 22% of the total excavation) must have been hardpan, hence his estimate of 38,703,637 cu. yds. of hardpan above given.

Mr. Gillette testified that this 22% allowance for hardpan was fully three times too high. He also testified that it was not at all probable that branch lines built and acquired since 1898 had required as heavy grading as the work done before that time, and that, in any event, an estimate of increase in yardage would more properly be based upon the increase in the miles of railway "line" rather than in the increase in the miles of "track." The miles of "line" had only increased 33%, as compared with an increase of 46% in the track mileage. Mr. Gillette testified that while it was possible that bank widening had increased the original yardage 20%, he knew that no such increase had occurred in the 1,500 miles of line owned by the Northern Pacific in the state of Washington; but, even conceding that an increase in the widths of embankments had been made throughout the system, certainly no rock cuts had been widened, no hardpan dug, no loose rock excavated, and very little rip rap widened. Practically all bank widening had been made by steam shovels working in gravel pits, and that it was not right, therefore to increase the original yardage of solid rock, loose rock and hardpan by 20% when practically no such work had been done.

Mr. Darling's unit prices of re-production were arrived at as follows:

Clearing—	
Contract price per acre	$75.00
Transportation of men and tools	5.00
Total	$80.00

Grubbing—	
Contract price per station	$15.00
Transportation of men, etc	1.50
Total	$16.50

Earth—	Per Cu. Yd.
Contract price, average haul 400 ft.	$0.22
Overhaul	0.03
Transportation of men, etc	0.03
Total	$0.28

Hardpan and cement gravel—	
Contract price	$0.35
Overhaul	0.04
Transportation of men, etc	0.03
Total	$0.42

Loose rock—	
Contract price	$0.42
Overhaul	0.04
Transportation of men, etc	0.04
Total	$0.50

Solid rock—	
Contract price	$1.00
Overhaul	0.05
Transportation of men, etc	0.05
Total	$1.10

Riprap—	
Contract price, per cu. yd	$1.75
Extra haul and work	0.15
Transportation of men, etc	0.10
Total	$2.00

As to the unit prices for grading, Mr. Gillette testified that all the contract prices were very liberal, and that the allowances for overhaul and transportation were fully three times too high. The unit prices for clearing were too high, because most of the clearing was light clearing, a great deal of it being sage brush. The unit price for riprap was excessive, except for hand placed riprap, and that ordinary riprap could be contracted for at $1.25 or less.

The cost of the track was estimated as follows by Mr. Darling:

Cost per mile of main track:

117 tons steel at St. Paul at	$31	$3,627.00
7.3 tons angle bars at	34	249.66
0.75 tons bolts and nuts at	55	41.25
3.4 tons spikes at	42	143.48
7.5 tons tie plates at	44	330.00
135.95 tons handled in material, yard, at	1	135.95
1 extra switch, per mile		27.50
Contract price for laying track		357.50
Train service and rent of equipment used in hauling to the front		375.00
3,000 ties at	0.55	1,650.00
Transportation of ties, rails, etc. (steel hauled 1,000 miles and ties hauled 400 miles at 0.4 ct. per ton mile)		1,023.80
3,000 cu. yds. gravel ballast at	0.66	1,980.00
Total, per mile		$9,941.14

Cost per mile of branch lines:

97 tons steel at St. Paul at	$31.00	$3,007.00
6.46 tons angle bars at	34.20	220.93
0.75 tons bolts at	55.00	41.25
3.4 tons spikes at	42.20	143.48
107.61 tons handled in material yard, at	1.00	107.61
1 extra switch		27.50
Contract price for track laying		375.50
Train service, hauling to the front		375.00
2,880 ties at	0.55	1,584.00
Transportation of steel and ties		891.24
1,500 cu. yds. ballast at	0.66	990.00
Total, per mile		$7,763.51

The ballast was estimated thus:

	Per Cu. Yd.
Contract price	$0.27
Repairs to steam shovels, etc.	0.03
Transportation 1½ tons, 60 miles at 0.4 ct. per ton mile	0.36
Total	$0.66

In testifying regarding these quantities and prices, Mr. Gillette stated that the Northern Pacific was not fully tie plated even on its main line; that the contract price for track laying was excessive; that the allowance for train service was nearly three times what such service actually costs; that the price of ties was excessive; that the estimated price of the gravel ballast was at least 50% too high, and that the quantity of ballast per mile was fully 50% in excess of the actual quantity.

Mr. Darling estimated the cost of each turnout as follows:

Set of switch ties	$54.00
Switch stand	13.30
Connecting rod	1.65
Frog	33.00
Split switch	31.00
Rail braces	1.60
Switch lamp	5.00
Guard rails	8.80
Freight charges	14.40
Total	$162.75

For the weight of rail used, and considering the character of the average turnout, this estimate is high.

Mr. Darling estimated the cost of the tunnels on the system as follows:

3,390 lin. ft. tunnels under 700 ft. in length.
1,090 lin. ft. tunnels of 700 to 1,200 ft. each.
7,548 lin. ft. tunnels of 1,200 to 4,000 ft. each.
9,833 lin. ft. tunnels, very long tunnel.

The above are single track tunnels lined with concrete. Beside these there were 4,919 lin. ft. of single track tunnels lined with wood, and 1,656 lin. ft. of double track tunnel lined with concrete.

The cost of single tunnels per lineal foot was estimated as follows:

Concrete lining—	Per Cu. Yd.
Contract price	$9.00
1¼ bbls. cement	2.50
Freight	1.00
Total	$12.50

With concrete averaging 2 ft. in thickness, there would be 4.1 cu. yds. per lin. ft.; hence the cost of lining would be 4.1×$12.50=$51.25 per lin. ft. of tunnel.

The cost of short tunnels (up to 800 ft.) was estimated as follows per lin. ft.:

	Per Lin. Ft.
Contract price	$50.00
Add 10% for extra excavation to make room for lining	5.00
Concrete lining	51.25
False work	13.00
Total	$119.25

For similar tunnels lined with wood instead of concrete, the estimate was $24.75 per lin. ft. for wood lining plus $55 for excavation, making a total of practically $80.

For longer tunnels the item of lining remained the same, but the item of excavation was estimated as follows:

Length of tunnel.	Price per ft.
Up to 700 ft.	$50 plus 10%=$55.00
700 to 1,200 ft.	$55 plus 10%=$60.50
1,200 to 4,000 ft.	$75 plus 10%=$82.50
4,000 to 10,000 ft.	$90 plus 10%=$99.00

The 10% is added to cover the cost of the extra excavation to make room for the lining, and to these prices must be added the cost of the lining itself.

Mr. Gillette testified that the unit prices for tunnel excavation were very liberal, and that the allowance for lining was excessive. The allowance for "falsework," he said, seemed to be in error by a misplaced decimal point, and would be nearer correct if it were $1.30, since it could refer to nothing but the materials used in the forms, centers, etc.

Mr. Darling's estimate of the cost of short double track tunnels was as follows per lin. ft.:

Contract price $50 plus 10%	$55.00
11.5 cu. yds. extra excavation at $3.	34.50
5.2 cu. yds. concrete at $12.50	65.00
Falsework	13.00
Total	$167.50

Mr. Darling's estimate of bridges was not given in much detail, but was as follows:

Howe truss bridges	$694,580
Steel and combination bridges	9,950,248
359,000 lin. ft. trestles at $10	3,590,000
Trestles filled with earth	3,012,415
Total bridging	$17,247,243

Other items were estimated as follows:

4,575 miles fencing at $154.55	$707,200
Water supply	1,071,200
1,750,000 sq. ft. wharfs and docks at $0.70	1,725,000
Coaling stations	635,936
3,412,000 sq. ft. stock yards at $4.48	152,857
74 track scales at $1,456	107,671
3,464 cattle guards at $16.80	57,195
Roundhouses, turntables, power houses, etc.	1,680,448
Shop buildings	2,091,650
Ware houses	2,886,016
Headquarters building	756,600
Passenger stations	1,102,304
Combination stations	1,408,960
Interlocking plant	123,555
Mile posts and signs (5,785 miles at $22.40)	129,584
Ash pits	79,067
Oil and sand houses at $1.68 per sq. ft.	120,960
Block system	44,307
Misc. buildings and piping	1,578,528
320 miles snow fences at $1,680	537,600

The above costs include freight on the materials, and, in nearly every instance, this freight was estimated at 12% of the unit price assumed; thus, oil and sand houses were estimated at $1.50 per sq. ft. plus 12% for freight, making a total of $1.68 per sq. ft.

The following unit prices for building were used by Mr. Darling, and do not include freight:

Frame round houses, per stall	$1,300.00
Brick round houses, per stall	2,100.00
Turntables, each	5,000.00
Brick shops (1-story) per sq. ft.	1.50
Brick shops (2-story) per sq. ft.	2.50
Frame shops (1-story) per sq. ft.	1.00
Frame ware houses, per sq. ft.	1.20
Brick ware houses, per sq. ft.	1.60
Frame passenger stations, per sq. ft.	1.50
Brick passenger stations, per sq. ft.	2.50
Frame combination stations (1-story) per sq. ft.	1.50
Frame combination stations (2-story) per sq. ft.	2.50
Oil and sand houses, per sq. ft.	1.50

Mr. Darling failed to give the number of square feet of each of these different kinds of buildings.

For purposes of comparison, Mr. Gillette rearranged the foregoing figures of cost, following the classification used by the Interstate Commerce Commission, and divided each item by 5,875 miles, which is the mileage of main line and branches on the Northern Pacific system. The following table gives the results of this calculation, showing the cost per mile of main line and branches, and the percentages:

	Per mile.	Per cent.
1 Engineering	$ 1,027	2.04
2 Grading	12,814	25.44
3 Tunnels	670	1.33
4 Bridges, trestles and culverts	3,722	7.38
5 Ties	2,719	5.40
6 Rails	4,850	9.63
7 Frogs and switches	342	0.68
8 Track fastenings	705	1.40
9 Track laying	1,128	2.24
10 Ballasting	1,776	3.53
11 Fencing	116	0.23
12 Crossings, cattle guards and signs	30	0.06
13 Interlocking and signal	25	0.05
14 Telegraph lines	247	0.49
15 Station buildings	1,138	2.26
16 Shops and roundhouses	675	1.34
17 Machinery and tools	186	0.37
18 Water stations	337	0.67
19 Fuel stations	111	0.22
20 Warehouses	488	0.97
21 Docks and wharves	292	0.50
22 Miscellaneous structures	403	0.80
23 Interest	3,860	7.66
24 Marine equipment	106	0.21
25 Contingencies	3,509	6.97
26 Freight equipment	5,202	10.32
27 Passenger equipment	1,002	1.97
28 Locomotives	2,804	5.57
29 Floating equipment	86	1.17
Total	$50,370	100.00
Total	$295,916,693	
Right of way and station grounds	107,772,743	
Grand total	$403,689,436	

The above does not include lines in Manitoba, estimated to cost $7,000,000 to reproduce, nor the coal properties valued at $50,720,120.

It will be noted that the $50,370 per mile multiplied by the 5,874.91 miles does not give exactly the total of $295,916,693. This is due to the fact that a slide rule was used in computing the cost of each item per mile, and absolute precision was not obtained. However, the error is only $4 per mile.

The reader should also note that the above costs per mile are not costs per mile of track, but per mile of all main and branch lines. Since there are 7,694.79 miles of all track, and only 5,874.91 miles of main and branches, there are 0.77 mile of main and branches for each 1.00 mile of "all tracks." Hence if we multiply any of the above 29 items by 0.77 we shall have the cost per mile of all tracks. Thus, item 9, Track Laying, is $1,128, which is the cost per mile of main line and branches, sidings and yards being lumped in. But the estimated cost of laying each mile of every kind of track is 0.77×$1,128 =$868.

In our issue of June 22, 1907, are given estimates of the cost of all the railways in Wisconsin and Michigan. In a subsequent issue we shall give the estimated cost of the Great Northern Ry. system. A comparison of these various estimates should prove instructive to every engineer interested in railway construction.

Methods and Cost of Constructing a Brick and Steel Wire-Glass Plant at Greensburg, Pa.

BY A. E. DUCKHAM,* C. E.

In the spring of 1907 the writer was called upon to design a building for a wire-glass plant in South Greensburg, Pa., for Pittsburg and Greensburg capitalists, known as the Arbogast-Brock Glass Co.; the wire-glass to be made under a new process of Mr. John Arbogast, who is now superintendent of the plant which has been completed. The building, which is 60 x 170 ft., was started (breaking ground) on May 20 and was finished by the author on Aug. 1. This includes the lehr (furnace) foundations.

The foundations up to the level of the ground are of concrete, made of 1 part cement (Portland), 3 parts sand, and 7 parts gravel. They were carried down to clay, which on an average was 3 ft. below the surface of the ground—which was level. The ground being marsh-like, the trenches were dug and immediately filled up with concrete, mixed on the board and deposited by wheelbarrow from a plank runway into the bottom; no water was required in the mixing-board for the bottom layers of concrete owing to the trenches being partly filled with surface water. After standing all night we would find the trenches filled with water in the morning; this we pumped out with an ordinary hand-pump and trench suction hose (about 3 ins. in diameter). At times, it kept one man busy pumping all day, owing to the heavy rains to which we were subject, which kept the ground saturated. The surrounding flat of about four acres is also owned by the company.

Above the level of the ground the building is of brick. The roof-trusses are of steel, including the purlins. They rest on the pilasters of the wall, and are attached to them by anchor bolts. The latter were set loose in the walls; and, after the erection of the steel, were grouted with cement mortar. This was to facilitate the erection of the steel-work.

The roof was covered as follows: Nailing strips of 2 x 4 in. hemlock were bolted (every 3 ft.) to the steel purlins, and upon them was nailed 1⅜ in. matched yellow-pine sheathing; upon this was laid and fastened Carey's Magnesia Flexible Cement Roofing.

The building was well situated for receiving materials, as it was located 118 ft. from the railroad and 75 ft. from a street. The cement, sand, gravel and brick were obtained from local dealers within a mile of the place; the first three were hauled by wagon (with the exception of one carload of sand), and the last one was shipped in by car on a siding opposite the building, and slipped in by a chute—the railroad track being about 8 ft. above our ground.

---

*1213 House Bldg., Pittsburg, Pa.

The walls between the pilasters are only 9 ins., but the pilasters project 9 ins., thus making an 18-in. pillar or column under each truss to carry the load; the 9-in. wall between acting as a curtain wall. The brick wall was laid complete in cement mortar, no lime being used. The mortar was composed of 1 part of cement and 2⅔ parts of clean river sand. When the building was finished, the mortar was so hard that it was difficult to break it with a hammer. We had some trouble at first with the bricklayers to get them to use this mortar without the addition of lime, as it is not easy to spread. When set up, however, it lasts for all time.

The cement, an American Portland, gave us perfect satisfaction. This was used throughout—in foundations, brick walls and lehr (furnace) foundations. Partly in the lehr foundation we used furnace slag from the steel works in place of gravel, we being unable to obtain the latter in time. It was very satisfactory, but required much more water in mixing—which had to be carried from a creek about 100 ft. distant.

The steel half trusses were skidded off the cars onto the ground, brought into the building after the erection of the walls through one of the large doorways on a "buggy," riveted together to form complete trusses, and then raised into position by a gin-pole, block and tackle, and crab (the latter being operated by six men). There were ten steel erectors, and it took them about ten days to erect the steel-work, including trusses, purlins, lateral bracing (in three bays) and "sag rods." A day or so was lost, however, waiting for tools and material.

On the original plans we figured on regular ventilators or lanterns with side louvres of sheet steel extending the whole length of the ridge of the roof for ventilation; but at the suggestion of the owners, to save cost, these were omitted, and four ordinary circular ventilators were used along the ridge. As there were many large windows along the sides of the building, as well as the ends, there were considered enough for the purpose. The windows had boxes for pulleys and weights. There were two sash to each window. The bottom sash weighed 39 lbs. including the glass: this was weighed to determine the size of counter-weights.

The 122 squares of roof-covering took one week to lay, nail, cement, and paint. There were five men for three days and two men for six days. Two men (experts) came up on the job, and three ordinary local mechanics were hired. The extra men cost $20.

In unloading the brick from the cars on the railroad track, in one case it took five hours to unload one box car of 12,000 brick with four men (two inside and two outside), with chute; and in another it took 3¾ hours for five men to unload the same car.

The building was not only designed by the author as engineer and architect, but he also had the contract to erect the building complete on the "cost-plus-a-fixed-sum" plan. By this method, the owners saved at least $2,000 figuring on the lowest bid—or about 25 per cent of the net cost (not taking into account the architects and contractors' commission). The building was originally intended to be built at Carnegie (about five miles from Pittsburg), but was finally built at Greensburg (over 30 miles from Pittsburg), where everything, owing to the increased distance from a large city and a river (for sand and gravel), cost more. The bids were figured on the Carnegie location, consequently the percentage showing the amount saved in cost should be increased.

The average lump bid of the contractors was about $11,500, but this was for the Carnegie location. To show the increased cost of the same building at Greensburg, we got a bid on the brickwork from the same man of $1,955 at Carnegie and $2,400 at Greensburg, or an increase of over 22 per cent. Again cement cost $1.75 per barrel at Carnegie and $1.85 at Greensburg, while sand cost 7½ cts. a bushel at Carnegie and 9 cts. at Greensburg.

The detailed cost of the building as built was as follows.

Steel-work	$2,730.00
Lumber, doors and windows, sheathing, etc.	1,283.64
Roof covering (cement roofing felt)	412.50
Cement, sand and gravel	938.04
Brick	738.45
Labor (including common labor, bricklayers and carpenters)	2,175.58
Bolts to fasten nailing-strips to purlins	28.88
Hardware	79.54
Ventilators (circular)	18.00
Total	$8,404.63

The cost of the building per cubic foot of space from the ground level to the roof was 3¼ cents. The cost per square foot of floor space was 82.4 cts. The above does not include the architect's fee of 5 per cent or the contractor's fee (of approximately 8 per cent): this would bring the cost per cubic foot up to 3.6 cts, and the cost per square foot up to 93.1 cts.

The building was filled in to a depth of 4 ft. with dry earth and burnt sand (from a foundry near by). It was originally intended to lay a cement floor upon this, or a brick floor (preferably the latter, as being easier to take up for the additional lehrs); but this was abandoned for the present, until the filling would become well tamped down by walking and by rolling trucks over it.

The lehr walls (foundation) were built by the writer under a separate contract with the furnace contractors. This work he did for $6.50 a cubic yard for the concrete walls (3 ft. under ground and 4 ft. above ground) and 50 cts. a yard extra for excavating [illegible] trenches. At this [illegible] he made 18 per cent profit. There were some advantages and some disadvantages. Under the head of advantages were the facts that his foreman, who was overlooking the main building, also took charge of this work; then for casing or forms for the concrete we used sheathing and lumber afterwards used on the building; under the head of disadvantages were the handicaps of having to carry water for the concrete and that we were held up by the steel erectors, who got in our way. The carpenter work in building the forms for the concrete lehr foundations amounted to 10 per cent of the total labor bill. The total labor bill amounted to 28 per cent of the total cost, and the materials (cement, gravel, slag, and sand) consequently run up to 72 per cent of the total cost. Runways were built of inclined planks, and the concrete was deposited by wheelbarrows directly into the forms and then tamped. The writer believes in rather a wet mix of concrete, tamped enough to bring the water to the surface, and make it liver like (quaking).

Inclined runways and scaffolding of 2-in. plank and doubled 2 x 4-in studs as posts were also used in the main building to supply the bricklayers with brick and mortar. Up these, common laborers wheeled the material in barrows; thus doing away with the slow and more expensive hod-carriers and ladders. The material used in the construction of the runways and scaffolds was afterward used in the room, so there was but little waste of lumber.

The plans, with the exception of the details, were made on ⅛-in. scale, instead of the usual ¼-in. scale. This smaller scale made it more convenient in the field, and not so cumbersome, especially when there was a strong wind. The writer believes that as small a scale as possible should be used, and all details should be made on a separate sheet on say 1 in. or 1½-in. scale. Figures in all cases should be given instead of depending on the scale: this would remove all doubt and controversy. In fact we should follow the procedure of the bridge drafting room.

In designing the building, no attempt was made at ornamentation, as the owners wanted the building to cost as little as possible; but the writer saw to it that everything was strong and efficient.

The brick-work was laid in English Bond, the strongest kind; and the writer was surprised to find how few of the so-called practical bricklayers knew what it was or how to lay it. Most of them thought that it was Flemish bond—or alternate headers and stretchers—instead of alternate layers of headers and stretchers, which is the English Bond.

In an effort to ward off the evil of gas leakage, concrete curbing 5 ft. deep has been built around all the new parks located in the populous districts of Chicago, Ill.

Cleaning Steel Work by Sand Blast and Painting by Compressed Air.*

At the U. S. Naval Station, Key West, Fla., are two large steel coal sheds whose vertical side walls are composed of ¼-in. steel plates, and are from 16 to 20 ft. high. The action of heat and impurities in the coal, combined with that of the large quantities of salt water used for extinguishing spontaneous combustion fires rapidly corrodes the interior steel work and necessitates its thorough cleaning and painting every time the sheds are emptied.

Shortly after the writer was detailed to this station his attention was attracted to this subject, and he concluded that the use of a portable sand blast cleaning and spray painting outfit would be very advantageous in point of efficiency and time as well as cost. This idea meeting with the approval of the Bureau of Yards and Docks, the following outfit was purchased, at a cost of $2,090, delivered at the naval station:

1 horizontal gasoline engine, about 20 HP.
1 air compressor, capacity about 90 ft. of free air per minute compressed to a pressure of 30 lbs. per square inch in one stage, belt connected to engine.
1 rotary circulating pump, belt connected to engine.
1 galvanized steel water tank.
1 air receiver, 18x54 ins.

(The above apparatus was all mounted on a steel framed wagon with wooden housing.)

2 sand blast machines, capacity 2 cu. ft. of sand each.
2 paint spraying machines, one a hand machine of ⅔ gal. capacity for one operator, the other of 10 gals. capacity for two operators.
100 lin. ft. of sand blast hose.
200 lin. ft. of pneumatic hose for sand blast machines.
400 lin. ft. of pneumatic hose for painting machines.
100 lin. ft. of air and paint hose for painting machines.
4 khaki helmets, with mica-covered openings for the eyes.
200 lin. ft. of 2-in. galvanized iron pipe.

Previously to the delivery of this material shed "A" had been emptied of coal and the work of cleaning the inside surface of the wall plates was begun by hand in the usual manner. About 7,000 sq. ft. out of a total of 9,000 were thus cleaned at a cost of slightly over 4 cts. per sq. ft. On the arrival of the sand blast outfit the hand work was stopped and after a short preliminary trial the machine cleaning was started. The work proceeded rather slowly until the men became accustomed to it, yet the 2,000 sq. ft. of previously untouched surface was thoroughly cleaned and the 7,000 sq. ft. of hand cleaning was all gone over and much improved at a total cost for labor of $97.68 and for gasoline of $10.15. The force consisted of the following:

	Per day.
1 engine tender	$ 3.04
1 helper (in charge of the work and tending machines)	2.24
2 laborers on machines, at $1.76 each	3.52
1 laborer drying sand, filling machines, etc.	1.76
Total	$10.56

From 10 to 15 gallons of gasoline were required per day of 8 hours (costing 19 cents per gallon here).

For the painting the coal tar paint originated by Civil Engineer A. C. Cunningham, U. S. N., was used. This paint was prepared with the following proportions (by volume): Coal tar, 4 parts; kerosene oil, 1; Portland cement, 1.

The Portland cement was first well stirred into the kerosene oil, forming a creamy mixture; this mixture was then carefully stirred into the coal tar. It was freshly mixed as needed and kept well stirred. The cost of this paint at Key West is about 15 cts. per gallon. It was found not to be so well suited to the pneumatic spraying machine as oil paint, but worked very well; though, of course, the machine used considerably more than hand work. In all, on this shed, 64½ gallons of paint were required for 9,000 sq. ft., or about 1 gallon to 140 sq. ft. The force used in painting was the same as in cleaning, with the addition of a laborer, who followed up the painters with a long handled brush and spread the paint uniformly. The cost of painting this shed was: For labor, $28.16; for gasoline, $3.80.

On shed "B" a total area of 12,500 sq. ft. was cleaned and painted. This steel work was covered with a scale nearly ⅛ in. thick and was deeply pitted. The scale and rust were very tough and extremely hard to remove. On this work it was found economical to keep men ahead of the sand blast with sledges, loosening and shaking off as much of the scale as possible. The labor cost of the whole work on this shed (cleaning and painting) was $460, including the cost of moving, setting up and removing. Gasoline cost $81. A total of 86 gallons of coal tar paint was used, covering about 145 sq. ft. per gallon. Total cost of labor, fuel and paint, $553.90, or 4.4 cts. per sq. ft. It is impossible to separate the cost of cleaning and painting on this work, as only small areas are painted at one time, the painting being done by one operator, the other working the sand blast. This was done in order to expose the cleaned steel to the atmosphere for as short a time as possible.

A fine silica sand was used, that being the only kind available except coral sand, which was tried, but found to be too soft. A coarse sand would probably have been more effective. The sand was all saved, dried and re-used several times. About ½ cu. yd. of fresh sand was required daily. The sand must be kept perfectly dry for this purpose, and there are patent sand driers manufactured. Very good results were obtained on this work, however, by the use of a sheet of boiler plate set up on bricks with a wood fire underneath.

No claims are made of extreme economy in the above work. The extremely thick and tough scale to be removed, the high fuel and labor cost of compressing air simply for this work, and (probably) the lack of the best kind of sand for the purpose, combined to make the work expensive. With these drawbacks it was, however, considerably cheaper than hand work and, what is more important, the cleaning was much more effective and thorough than could possibly have been done by hand.

---

* Reprinted from an article by De Witt C. Webb in Engineering News, Sept. 19, 1907.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0671. **Concrete Mixers.**—Nims Concrete Machinery, Philadelphia, Pa.

The mixer described in this 14-page pamphlet is a double tube mixer, one tube being let into the other so as to form a continuous vessel for the batch. The tubes are cast into one piece. The mixer is designed to be fed by belt conveyor from an automatic measuring and proportioning hopper mounted separately on trucks. Claim is made that a mixer running out 60 cu. yds. per hour can be operated by a 5 H. P. engine. The machine is an interesting one and contractors should investigate it.

No. 0672. **Deep Well Pumps.**—Keystone Driller Co., Beaver Falls, Pa.

Besides complete catalog data of deep well pumping machinery this 60-page pamphlet contains an excellent description of the construction of Downie pumps and several pages of tables and information of value to waterworks engineers.

No. 0673. **Asbestos Wood.**—H. W. Johns-Manville Co., New York.

A 20-page leaflet, describing asbestos wood, a material that is said to be worked with wood working tools, and is slightly harder than wood. Can be used for doors, wainscoting and almost any building purpose. Is said to be absolutely fireproof, not even warping under great heat or by having water thrown on it. Various uses for this material are described.

No. 0674. **Reinforced Concrete Factories and Warehouses.**—Turner Construction Co., 11 Broadway, New York.

An 8 page bulletin illustrating concrete structures of various kinds and designs built by this company, including factories, warehouse, tanks, large bins, power houses, stables, cold storage plants and many other structures.

No. 0675. **The Rotary Disc Plow.**—Disc Grader & Plow Co., Hunter, North Dakota.

This rotary disc plow, which is manufactured for use on elevating graders is illustrated and described in a small pamphlet. The output of a grader is said to be increased by this plow, as it is light running, enabling the teams to cover a greater distance, and it will throw out of the way of the machine rocks and boulders, besides cutting through long grass and weeds in wet places with great ease.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

Bankers' Engineers 231

CONCRETE SECTIONS

Tests of Cast Iron and Reinforced Concrete Culvert Pipe. 232

EARTH AND ROCK SECTION:

A Steam Shovel Attachment for Traction Engines 235
The Method of Sinking a Shaft in the Joplin District with Power Drills 235

GENERAL ARTICLES:

Ten Additional Letters Commending the American Society of Engineering Contractors 237
The Method and Costs of Laying a Submerged 12-in. Water Main. 238

METHODS AND COSTS:

Protecting Water Pipe from Freezing —Data on a Sand-Clay Road—Tests of Creosote Oil for Paving Blocks—Estimated Cost of Producing Ties—Cost of Two Small Surveying Jobs 241
CATALOGS WORTH HAVING. 242
PERSONALS 242

Banker's Engineers.

The owner's engineer, the manufacturer's engineer and the contractor's engineer all play well recognized and distinctive parts in modern public utility developments. Are we about to add to this list the banker's engineer? It is intimated that we are in a paper presented to the Western Society of Engineers by Mr. J. C. Kelsey, an engineer of somewhat wide experience in the financing of public utilities and consequently familiar with bankers' methods. Mr. Kelsey asserts flatly that: "The banker who sells securities should father them. He should be responsible for them and should be willing to buy them back at any time that there is a hitch in the interest payment or any entanglement thereupon." We shall not attempt to say how these assertions will be regarded by that class of bankers which Mr. Kelsey calls "security fakers" or even by the class commonly spoken of as "old time bankers." It seems plain, however, that if such a condition comes to pass we may expect to have securities that are reasonably secure and that we shall see fewer public utilities, of a certain kind at least, being developed.

To engineers greater interest lies in the answers that Mr. Kelsey suggests to the following questions: What promise is there that the condition of safe banking stipulated above will ever come about? If such a condition does come about what role will the engineer play in the new banking? Finally of what sort must the special training of the bankers' engineer be?

In reply to the first question Mr. Kelsey argues that "the day is coming when all public utilities will have to take a defined position. Through the medium of broad-minded state commissions, properties will be conducted differently in the future. They will have to meet public demands promptly. They will not dodge taxes. They will be responsible for their employes' safety. They will have to co-operate with municipalities in beautifying cities. They will have to maintain renewal reserves and shall be ordered to invest them by law. Under the new order, securities will be guaranteed because the property has conformed to the commission's orders. There will be many things required of the companies that would give the present directors and legal advisers apoplexy." That the trend of development is along these lines we think that most of our readers will agree. They will further agree, we also think, that the change will not be the matter of a moment but of long growth. However this may be, the natural inquiry is: in what capacity is the engineer to play any particular part in this new arrangement of affairs? The answer we quote from Mr. Kelsey's paper:

"If the banker does not wish to be deceived as to the worth of the property he must have competent advice. Not only must the auditor go over the books, but the engineer must go over the physical property. He must understand the needs of the property, not only now, but 10 or 20 years hence. He must thoroughly understand depreciation. He must be thoroughly familiar with the best operating methods and able to judge exactly as to the competency of the management.

The engineer must be a business man. Engineering is a business and not a profession, as some are determined to have it. The successful engineer may stand for ideals, but he bears in mind the natural demands of the banker and public, that the property receive sufficient money, pay out money, and, like the individual, save money for a rainy day. This homely expression signifies the necessity of what is called the renewal reserve. In all properties owned by security-holders there is a sacred necessity which lies in the saving of enough money out of the daily or yearly income to take care of all changes in the art, all destruction due to the elements, and to hold the value of a $100 security at $100 or over for all time.

"As the property wears out it decreases in value. Assume that, in a certain time, it decreases to a value of 90 cts. on the dollar. Then the security owner is entitled to be assured that the necesary 10 cts. is in the reserve treasury and available for the purpose of holding the value at 100 cts. on the dollar; in other words, to be sure that there will be no assessments, or cessation of dividends, to take care of depreciation.

"The engineer takes the following part in a contract between the banker and the property management, after the questions of reserve and other details are settled. The contract should contain the following thoughts at least:

"'The engineer of the bankers shall be furnished every facility to inspect the plans proposed for construction of extensions and improvements, the contracts and prices paid for labor, material and incidents connected therewith; and the work during its progress, in order that he may certify that the plans adopted are the most economical to produce the best results, that the prices paid are the lowest consistent with first-class work, and that the work has been executed with the terms of the mortgage. He shall have access to all operating departments, and shall be furnished with all desired information. He shall have power to make tests, and to criticize operating methods. He shall report directly to the bankers, and said report shall not necessarily be accessible to the active management of the property."

"It is understood that the contract gives the banker power to act upon the recommendations, but that is another story. With such a clause as this the banker has direct means of knowing accurately every vital point concerning the property he has so nicely described to the public. If the management of the property is niggardly with maintenance and repair, thereby rendering the contracted renewal reserve fund insufficient, the banker can call a halt. If the management is extravagant in operation and conduct of the business, thereby endangering bond interest, the banker knows it before it is too late."

The Isthmian Canal Commission has again extended the time for opening bids for furnishing 4,500,000 bbls. of Portland cement for the Isthmian Canal work. Bids are now to be opened June 1.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Tests of Cast Iron and Reinforced Concrete Culvert Pipe.*

I.

MECHANICS OF PIPES AND RINGS SUBJECT TO EXTERNAL PRESSURE

BY PROF. ARTHUR N. TALBOT.†

The tests were made on cast iron pipes and reinforced concrete pipes in the Laboratory of Applied Mechanics of the University of Illinois. The pipes used in the tests were furnished by five railroad companies which co-operated with the Experiment Station in the work, the Atchison, Topeka & Santa Fe Ry. System, Chicago, Burlington & Quincy R. R. Co., Chicago, Milwaukee & St Paul Ry. Co., Chicago, Rock Island & Pacific Ry. Co., and Illinois Central R. R. Co. Messrs. D. A. Abrams and W. R. Robison of the Engineering Experiment Station gave valuable assistance in the investigation. The tests were made between November, 1906, and January, 1908.

The tests were intended to throw light upon the strength of pipes placed in railroad embankments, but the results may be useful in discussions of sewers and other similar forms of construction. The main tests were made with a specially prepared testing apparatus which included a box of strong and stiff construction, and the pipes were embedded in sand and the load applied through a saddle which rested on a sand cushion. Auxiliary tests were made to connect the investigation with the action of the pipes in other methods of testing. Thus, rings which were cut from the spigot ends of the cast iron pipe were tested under concentrated load, and small test pieces were also cut out and tested. Short rings of concrete and reinforced concrete were tested, both under concentrated load and under distributed load. In different ways these auxiliary tests served to check up the phenomena of the tests of the pipes and to assist in interpreting the action of the testing apparatus, the distribution of the load, and the resisting strength of the structures themselves.

MECHANICS OF PIPES AND RINGS SUBJECT TO EXTERNAL PRESSURE.

Bending Moment and Conditions of Loading.—The stresses developed in rings subject to external earth pressure, as in sewers and railroad culvert pipes, are of course dependent upon the bending moments developed, and, as the exact load coming upon the ring and its distribution over the surface are difficult to determine, the bending moment is in general quite uncertain. The amount of the load and its distribution, and therefore the bending moments on different parts of the ring, depend upon a number of conditions, among them the nature of the earth used in the filling, the method of bedding the pipe, the way of tamping the earth at the sides, the amount of the lateral restrain or pressure of the earth horizontally, the method of filling and packing the earth above, the condition of moisture in the earth, etc. Evidently in such earth as quicksand, the conditions may approach those of external hydrostatic pressure, and on the other hand, in deep sewer trenches, the earth filling may act so that its weight is carried against the sides of the trench. In discussing the stresses in rings, it may be well first to find the bending moment for certain assumed conditions of loading, then to make tests under various conditions of loading, and finally to compare these results with a view of determining the probable range of bending moments under the actual conditions of construction. The assumed loadings may include:

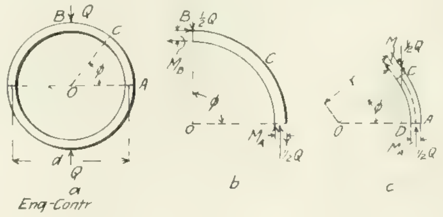


Fig. 1.

(1) A concentrated load at the crown of the ring.

(2) A vertical load distributed uniformly over the horizontal section.

(3) A distributed vertical load together with a horizontal load distributed perpendicularly over the sides of the ring.

(4) An oblique loading.

In these calculations, since much uncertainty is involved, the difference in the intensity of the load at the crown and at the extremities of the horizontal diameter, due to the different depths of earth, need not be considered. In general the pressures and distribution on the lower half of the ring will be considered to be the same as on the upper half. It is apparent that in a ring of considerable thickness in comparison with its diameter there is a different distribution of stresses from that found in thin rings, but for the rings under consideration the simplicity of analysis for thin rings will outweigh the small loss in accuracy. As refinements are not essential and approximations are permissible, the equations will be based upon a thin ring of homogeneous material having a constant modulus of elasticity and it will also be assumed that the changes from a circular form will have little effect upon the dimensions of the ring. As the derivation of the formulas is somewhat long, only the final equations will be given.

Concentrated Load.—For a load concentrated as shown in Fig. 1 (a), the quadrant shown in Fig. 1 (b) will be in equilibrium under the load ½ Q at B, a thrust ½ Q at A, a moment 0.091Wd at A, and a moment 0.159Wd at B. At B

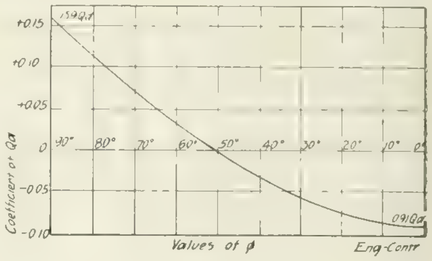


Fig. 2.

$M = 0.159Wd$ ....(1)

For a point C at an angle Φ above the horizontal diameter (Fig. 1 (c)), the equation for the bending moment is

$M = Qd\ (0.159 - \frac{1}{4}\cos\Phi)$ ....(2)

Figure 2 shows the changes in bending moment between the haunches and the crown. The point of zero bending moment is $\Phi = 50°\ 30'$. At this point the sign of the bending moment changes from negative to positive. The expression for the deflection of the pipe under concentrated load or for the change in vertical diameter is $0.0186\dfrac{Qd^3}{EI}$ and for the change in horizontal diameter is $0.0171\dfrac{Qd^3}{EI}$.

Distributed Vertical Load.—For a vertical load distributed uniformly over the

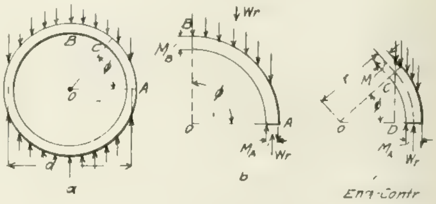


Fig. 3.

horizontal section as shown in Fig. 3 (a), the quadrant shown in Fig. 3 (b) will be in equilibrium under the load, a thrust at A, a moment at A and a moment at B. Calling the load on the ring W and the mean diameter of the ring d, the moments at A and B, which are equal, are given by the expression

$M = 1/16\ Wd$ ....(3)

For a point C at an angle Φ above the

---

*Condensed from a paper read before the Western Society of Engineers, April 15, 1908.

†University of Illinois, Urbana, Ill.

horizontal diameter, (Fig. 3 (c)), the equation for the bending moment is

$M = 1/16\, Wd\, (1 - 2 \cos^2 \Phi)$ ....(4)

In Fig. 4 is shown the change in bending moment between the haunches and the crown. The point of zero bending moment is $\Phi = 45°$. At this point the sign of the bending moment changes from negative to positive. The expression for the deflection of the pipe, or for the change in vertical diameter, is $1/96 \frac{Wd^3}{EI}$, and the change in horizontal diameter is the same.

Distributed Vertical and Horizontal Load.—If now we consider that the vertical load is uniformly distributed over the horizontal section of the pipe as before and that there is also a horizontal pressure uniformly distributed against the pipe, the loading will be as represented in Fig. 5 (a). If the ratio of the horizontal pressure to the vertical pressure is denoted by q, the moments at A and B will be given by the equation

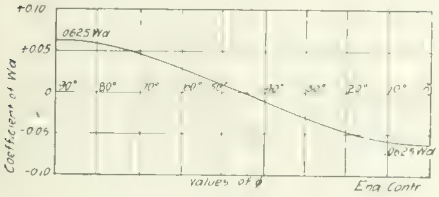


Fig. 4.

$M = 1/16\, (1 - q)\, Wd$ ....(5)

For a point C at an angle Φ above the horizontal diameter (Fig. 5 (b)), the equation for the bending moment is

$M = 1/16\, Wd\, (1 + q - 2 \cos^2 \Phi - 2q \sin^2 \Phi)$ ....(6)

The bending moment becomes zero at $\Phi = 45°$, as in the other case.

If the intensity of the horizontal pressure is the same as that of the vertical pressure, q = 1, and M becomes zero at all points. This corresponds to uniform external pressure, and equal compression is produced in all parts of the ring.

Oblique Load.—In the case of both the concentrated load and the distributed load it is seen that the bending moments at A and B are large and that the moment decreases to zero amount at some point between A and B. If we were sure that this loading obtained, no provision against bending need be made at the points of zero bending moment and but little for points close on either side. However, it must be borne in mind that if there is a change from the specified loading, the conditions of the bending moment are likewise changed. If, for example, the method of filling over the pipe should be such as to make the pressure come obliquely as shown in Fig. 6 (a), the maximum bending moment would be at the 45° points and the minimum moments at the ends of horizontal and vertical diameters. Similarly, if in a sewer trench, a slip of earth from the side caused the pressure to come against the sewer as shown in Fig. 6(b), the distribution and amount of the bending moment would be materially different from that of the vertical loading usually assumed. In the case of a large sewer in a shallow trench, during the time of filling, especially with the concrete still green, the direction of pressures indicated in Fig. 6 (c) would give bending moments quite unlike those before described. It will be necessary to make separate analyses for such cases. While an accurate measurement of the bending moments in such cases is impossible, yet in any case it is feasible to judge of the amount and location of the bending moments within reasonable limits and to provide strength in the section of the sewer to take the consequent stresses.

Resisting Moment and Stresses.—For a ring whose thickness is small in comparison with the diameter the difference in the length of the inner fiber and outer fiber is small and the expression for the resisting moment given for ordinary straight beams may be applied with a close degree of approximation. In the following formulas the length of the ring (width of beam) will be considered unity. Call *t* the thickness of the ring.

For the rectangular section of the ring the resisting moment will then be $1/6\, ft^2$ where *f* is the unit-stress at the remotest fiber. In those sections in which there is no thrust, the maximum stress (stress at the remotest fiber) may be found by equating the expression for the resisting moment and the expression for bending moment and substituting the numerical values at the section considered. If a thrust exists at the given section, this thrust may be considered to be uniformly distributed over the section and the stress will be equal to the sum or difference of the resisting moment stress and the thrust stress.

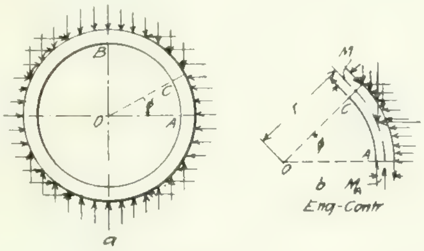


Fig. 5.

For a concentrated load at the crown (Fig. 1) the stress at B, since there is here no thrust, may be determined from the formula

$1/6\, ft^2 = 0.159\, Qd$ ....(7)

At A the same form of expression may be used for the resisting moment, but this must be combined with the stress due to the vertical thrust. Considering this to be uniformly distributed, the stress in the remotest fibers will be

$$f = \frac{Q}{t} \mp \frac{0.091\, Qd}{1/6\, t^2} \quad \text{.........(8)}$$

The — sign will be used for the outer fiber and the + sign for the inner fiber.

At [illegible] C (Fig. 1 (c)) [illegible] stress at the remotest fiber may be shown to be

$$f = \frac{1}{2}\, [illegible] \Phi \pm \frac{M}{1/6\, t^2} \quad \text{.........(9)}$$

For a uniformly distributed horizontal load the stress at the crown B will be

$$f = 1/16\, \frac{Wd}{1/6\, t^2} \quad \text{....................(10)}$$

and at A

$$f = \frac{1}{2}\frac{W}{t} \pm \frac{3}{8}\frac{Wd}{t^2} \quad \text{....................(11)}$$

and at any point C Fig. 3 (c),

$$f = \frac{Wr \cos^2 \Phi}{t} \pm \frac{M}{1/6\, t^2} \quad \text{...........(12)}$$

For a distributed vertical and horizontal load (Fig. 5) there will be a thrust both at A and B. The stresses at the crown B will then be given by the following equation:

$$f = \frac{qW}{t} \pm \frac{MB}{1/6\, t^2} \quad \text{..........(13)}$$

At A the extremity of the horizontal diameter

$$f = \frac{W}{t} \pm \frac{MA}{1/6\, t^2} \quad \text{..........(14)}$$

At any point C (Fig. 5 (b)), the expression for the stresses may be written

$$f = \frac{W \cos^2 \Phi}{t} - \frac{qW \sin^2 \Phi}{t} \pm \frac{M}{1/6\, t^2} \quad .(15)$$

These formulas are directly applicable to homogeneous elastic rings in which the modulus of elasticity of the material remains constant. These conditions are not strictly true for rings made of cast iron or of concrete or reinforced concrete. However, they may be applied without any great error to cast-iron rings and plain concrete rings at the breaking loads, if the modulus of rupture of the materials obtained under the same condition of thickness and loading be substituted for the maximum tensile stress *f*. It should be noted that the stress on the tension side will generally control.

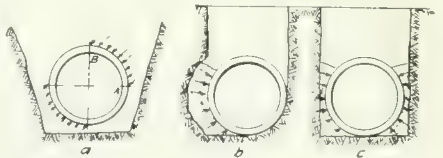


Fig. 6.

For a ring made of reinforced concrete the conditions differ somewhat from the foregoing. For ordinary cases it will not be far from the truth to equate the bending moment determined as above and the resisting moment of the reinforced concrete section. As the amount of reinforcement is usually much lower than that in which the circular beam would fail by compression in the concrete, we may, without material error, take for the resisting moment of the reinforced concrete section the value 0.87 Aft, where t is the distance from the compression face to the center of the steel reinforcement, A is the area of the cross-section of the reinforcement for a unit of width of ring, and f is the tensile unit-stress in the steel due to the bending moment. To equate the bending moment determined as above to this resisting moment, is not exactly correct, since among other reasons the neutral axis does not come at the center of the thickness of the ring (which is the point about which the bending moments were taken) and since the elastic curve is not the same as in a ring of homogeneous material. At sections where thrust occurs, as at A, Figs. 1 (c) and 3 (c), the tension in the steel determined as above will be reduced by the resisting compressive stresses there set up. The amount of the tension in the steel at the point A may be calculated by the formula

$$f' = f - \frac{\frac{1}{2} nT}{t(1 + np)} \qquad \ldots\ldots(16)$$

which is applicable for both concentrated and distributed loads. In this formula f is the tensile stress in the steel due to the bending moment, p is the ratio of the area of reinforcement for a unit width of beam to the distance between the center of the steel and the compression face of the concrete, T is the thrust or pressure against the face of the section, and n is the ratio of the moduli of elasticity of steel and concrete, which for the purposes of this calculation may be taken as 15. At the extremity of the horizontal diameter the thrust is W. At the crown it is zero for vertical loading, and for both concentrated and distributed load the greatest tensile stress is found at this section.

Conditions of Bedding and Loading Found in Practice.—The foregoing discussion assumes certain definite conditions of loading. These are useful in establishing definite formulas which may be used as a basis for calculations. It is not to be expected that these conditions represent accurately the condition of bedding and loading to be found in practice. It is then desirable that the nature and extent of possible or probable variations from these assumed conditions be discussed and the effects of such a divergence considered. The following are suggestions of variations; the engineer will easily extend the discussion by numerous examples taken from his own experience.

If the layer of earth immediately under the pipe is hard or uneven, or if the bedding of the pipe at either side is soft material or not well tamped as indicated in Fig. 7 (a), the main bearing of the pipe may be along an element at the bottom and the result is in effect concentrated loading. This condition may be aggravated in the case of a pipe with a stiff hub or bell where settlement may bring an unusual proportion of the bearing at the bell and the distribution of the pressure be far from the assumed condition.

In case the pipe is bedded in loose material, the effect of settlement will be to compress the earth immediately under the bottom of the pipe more completely than will be the effect at one side, as indicated in Fig. 7 (b), with the result that the pressure will not be uniformly distributed horizontally. Similarly, in a sewer trench, if loose material is left at the sides and the material at the extremity of the horizontal diameter is loose and offers little restraint, as indicated in Fig. 7 (c), the pressure on the earth will not be distributed horizontally and the amount of bending moment will be materially different from that where careful bedding and tamping give an even distribution of bearing pressure over the bottom of the sewer.

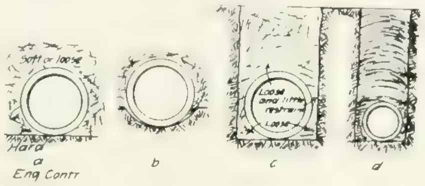


Fig. 7.

In the case of a small sewer in a deep trench, the load upon the sewer may be materially less than the weight of the earth above, in the case as shown in Fig. 7 (d), where the earth forms a hard compact mass and is held by pressure and friction against the sides of the trench.

In case a culvert pipe is laid in an ordinary embankment by cutting down the sides slopingly as shown in Fig. 8 (a), it is evident that the load which comes upon the pipe will be materially less than the weight of the earth immediately above it. If a culvert pipe replaces a trestle and the filling is allowed to run down the slope as shown in Fig. 8 (b), the direction and amount of the pressure against the pipe will differ considerably from that which obtains in a trench or in the case of a level filling shown in Fig. 8 (c). It is possible in the latter case that the smaller amount of settlement of the earth directly over the culvert pipe, due to the greater depth of earth on the adjacent sections, may allow a greater proportion of the load to rest upon the culvert pipe than would ordinarily be assumed.

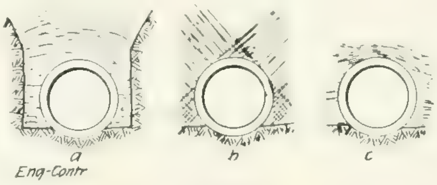


Fig. 8.

Attention should be called to the fact that the distribution of the pressure by means of earth under and over a ring assumes that the earth is compressed in somewhat the same way as when other material of construction is given compression. Unless the earth has elasticity, the distribution of pressure cannot occur. To secure the uniform distribution assumed, the ring itself must give enough to allow for the movement of the earth which takes place under pressure. This is especially true with reference to the presence and utilization of lateral restraint, and a ring which does not give laterally, as for example a plain concrete ring, will not develop lateral pressure in the adjoining earth under ordinary conditions of moisture and filling to any great extent. As the conditions of earth and moisture produce mobility and approach hydrostatic conditions, the necessity for this elasticity and movement do not exist, but here the lateral pressure approaches the vertical pressure in amount and the bending moments become relatively smaller.

The discussion is sufficiently extended to indicate the importance of care in bedding culvert pipe and sewers and in filling over them, and to indicate the great difference in the amount of bending moment developed with different conditions of bedding and filling. Where there is any question of needed strength, it will be money well expended to use care and precaution in bedding the pipe and in filling around and over it. I am convinced that a little extra expense will add considerable stability, life, strength, and safety to such structures, far out of proportion to the added cost. It is possible that under careful conditions of laying lighter structures may be used with a saving in the cost of construction.

The total amount of excavation done on the New York State Barge Canal from the beginning of work in May, 1905, to the end of 1907, amounted to 4,500,459 cu. yds. A comparison of the amounts of material excavated on the Barge Canal and the Panama Canal, according to the "Barge Canal Bulletin," is as follows:

	Panama Canal. Cu. yds.	Barge Canal. Cu. yds.
1st year of work....	243,472	716,676
2nd year of work....	1,799,227	1,406 705
3rd year of work....	4,948,497	4,500,459
4th year of work....	15,764,095	....

Excavation work on the Panama Canal began in May, 1904, and accordingly is one year in advance of the Barge Canal excavation work.

The mileage of the railways of Canada at the close of the year ended June 30, 1907, was distributed as follows among the several provinces: Ontario, 7,637; Quebec, 3,515; Manitoba, 3,074, Saskatchewan, 2,024; New Brunswick, 1,502; British Columbia, 1,685; Nova Scotia, 1,329; Alberta, 1,323; Prince Edward Island, 267; Yukon, 96; total, 22,452 miles. With double tracks, sidings, and spurs, the mileage amounted to 27,611 miles.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and rail-roads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

A Steam Shovel Attachment for Traction Engines.

Some months ago we published a description of a traction engine equipped with a dipper and used as a steam shovel. We now illustrate a somewhat similar machine, namely, an attachment to be quickly fastened to any traction engine. The illustrations show the arrangement.

The attachment is secured by clamps, neither bolts nor studs being put into the boiler. It is attached or taken off in a few minutes. The attachment consists of an A frame with a steam cylinder mounted in front of the boiler. The dipper arm is pivoted on the engine frame; the dipper, a flat pan, revolves in the fork of the dipper arm. The pan is dropped flat onto the ground, as shown in Fig. 1, and is loaded by the engine pushing it ahead. Then it is hoisted high enough for a wagon to drive under it, when the load is dumped, Fig. 2. The shovel will swing at right angles to the boiler, without the engine changing its position, so it will dump anywhere within 180°. The shovel is made of boiler plate with a cutting edge that can be renewed.

One man, the engineer, operates the whole machine, tripping the load from his position in the rear of the engine. To get the full capacity of the machine it is advisable to have a fireman to assist the engineer. For small jobs he is not needed.

In soft material the ground need not be plowed, but for good work in hard clays the ground should first be plowed, the engine being used to pull the plows. The machine is adapted to all shallow cutting and to cellar excavation. It is said that it will not only do the work of an elevating grader, but it can be used where a grader can not operate on account of lack of room. It will also work where the excavation would be too light to install a steam shovel. Likewise it can be used where wheel scrapers can be worked, and, with long hauls, the wagons will effect a saving over the scrapers.

Where the engine is of 15 to 18 H. P. a 1¼ cu. yd. shovel may be used, and with a 20-H. P. engine a 1½ cu. yd. shovel, which is about as large as can be practically handled, is used. In hauling in wagons with a 1¼ cu. yd. shovel the equipment can be depended upon to handle one cubic yard (place measurement), for each load. Long, shallow ditches can be made for irrigating and other purposes, without the use of wagons, by dumping directly onto the banks.

It has been stated that 600 loads have been handled in a day where 12 wagons were used, and the haul did not exceed 900 ft. On a 200-ft. haul it is claimed that with only 2 wagons 400 cu. yds. can be moved in 10 hrs.

By removing the dipper arm the attachment can be used as a derrick for loading boulders, stumps, logs and in fact any heavy material.

It is thought by the inventor that it would be useful in loading snow into wagons on city streets. Mr. C. Harlan Wolfe, of Charlotte, N. C., is the inventor, and the attachment is being manufactured by the Moffat Machinery Manufacturing Co., of Charlotte, N. C.

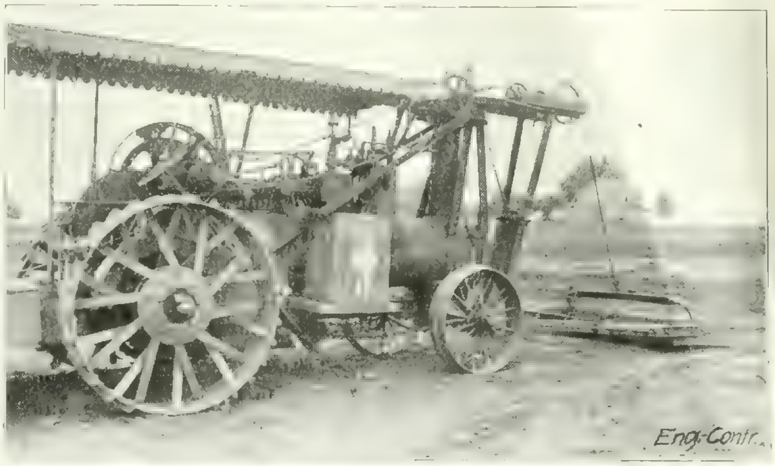


Fig. 1—Loading.

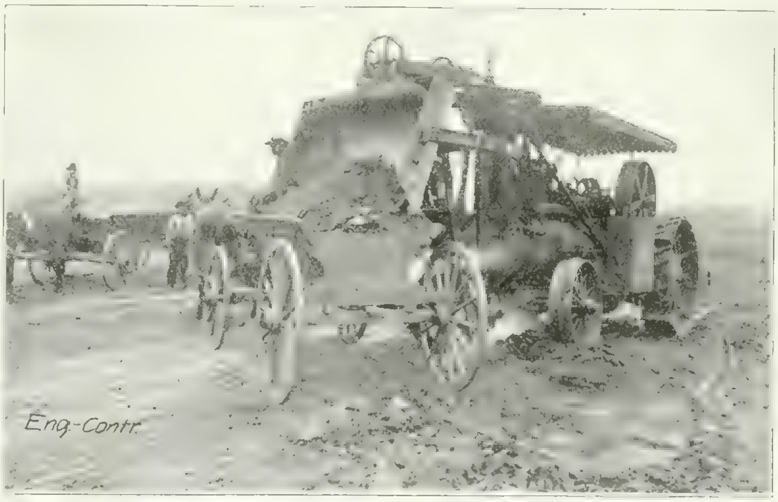


Fig. 2—Dumping Load.

The total value of work under contract on Feb. 1, 1908, on the New York State Barge Canal amounted to $22,340,426.

The Method of Sinking a Shaft in the Joplin District with Power Drills.[*]

The use of power drills in the Joplin (Mo.) district has grown in importance within the past six years. Within that period, in so-called hard-ground mines, hand-steel has been entirely abandoned and the power drill has taken its place.

In no other field of great importance as a mining center, does drilling occur entirely in chert. In most mines where the precious metals are obtained, the veins consist of silicious material and eruptive rocks. This is also the case with many of the deposits of lead and zinc. There are instances where important lead deposits occur in a limestone gangue. The Missouri-Kansas district, however, is peculiar in that the prevailing gangue of its hard ground deposits is brecciated residual flint cemented with a harder black secondary flint. In striking contrast, too, are the large horizontally bedded deposits of this field. These deposits vary in thickness from 4 to 30 ft., the ore being disseminated throughout this hard brecciated chert.

---

[*] Reprinted from an article by Otto Ruhl, in "Mining Science."

The practice of breaking the ground has grown into a set form. The type of drill most commonly used is the Sullivan U. C. and the Ingersoll C 24 for shaft sinking, and the Sullivan U. F. 2 and the Ingersoll E 24 for heavy stoping. There are lighter and heavier drills in use, but those named are in the majority. Air is used almost exclusively except in some prospect shafts where steam is employed. The steel has to be changed very frequently, varying with the hardness of ground and the degree of temper. Occasionally a bit will drill 2 or 3 ft., while in other instances a bit will have to be changed within 1 or 1½ ft. Very rarely, however, a 6-ft. hole can be driven without change. Two styles of bits are used. That most commonly employed is known as the bull-head bit, with cutting edge in a straight line. Where the mines are well developed and a drill-sharpening machine has been installed, the diamond-edged bit is used which has its cutting edge in the form of a cross. Two sizes of steel are employed, varying from 1 to 1½ in. In shaft sinking the holes are started with 1⅛-in. and finished with 1-in. steel. In stoping or drifting, 1½-in. steel is used in starting the holes, and 1⅛-in. to finish. The practice has shown that holes drilled deeper than 10 ft. should be finished with a still smaller steel. Very few stope holes are drilled deeper than 10 ft.

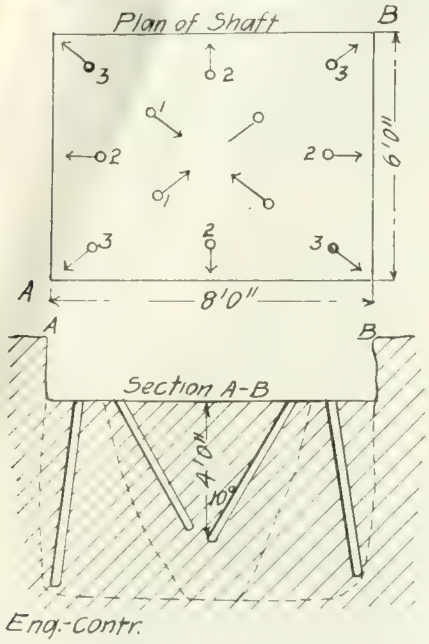


Fig. 1—Method of Drilling in Shaft.

After drilling the holes 9 to 10 ft. the holes are squibbed. Squibbing is the process of enlarging the drill holes at their bottom by the use of a small quantity of powder. This makes it possible to load the holes heavier, lifting more ground than if charged without being enlarged. Squibbing is accomplished by ramming from one-half to one stick of dynamite in the bottom of a hole and fired. If the ground is exceptionally hard the hole is squibbed three or four times in order to obtain the necessary powder space. The hole is then cleaned with a blower made for that purpose. Squibbing sometimes enlarges the hole sufficiently to take from 50 to 75 sticks of powder. The powder commonly employed is 40 or 60 per cent dynamite, according to the hardness of the ground.

Powder drills meet with difficulties in this field. As the ore body is made up of a brecciated mass cemented by a harder black flint and the softer ore, many crevices and openings occur. The sudden breaking of the hole into one of these openings is attended with danger to the machine. The bit is often wedged or stuck and is dislodged with difficulty. Should the drill strike a corner of such openings it is often pulled out of line which causes delay and sometimes results in the loss of the hole. The same result comes from the difference in the hardness of the two kinds of flint rock and the ore. The breaking of piston heads is a regular item in the monthly expense bill of hard ground mines. Another difficulty occasionally met, especially in mines in Kansas and Oklahoma fields, is gumming from bitumen drippings in the ore body. A drill-bit soon clogs when an opening holding this bitumen is penetrated. Water will not remove it, and unless repeated squibbing cleans out the hole, drilling becomes slow and expensive.

These difficulties reduce the average efficiency until the amount drilled during an 8-hr. shift by one machine man and a helper, seldom totals more than 45 ft. This is considered good average practice over the entire camp. With the wages of the machine men at $2.25 per day, and the helper at $1.75 to $1.85, the labor cost per foot amounts to 9 1-9 cents. This wage scale has been in force since the shut-down in November of 1907. The average execution of the rounds of holes placed and pointed according to the system of drilling in this field, has resulted in the rules that a ton of ore is broken for every pound of powder used in stoping; and in shaft-sinking, where the shaft is 6 ft. by 8 ft., in limestone or flint, from 20 lbs. to 25 lbs. of powder are required for every foot in depth.

Two sizes of shafts are found in this field, 4 x 6 ft. and 6 x 8 ft. The first, and smaller size, is usually sunk in soft-ground deposits, or where the shaft is largely prospective. In the sheet-ore camps, where the low grade of the ore make it necessary to handle it in large quantities, the shafts are of the larger size to facilitate rapid hoisting. In these shafts one compartment is used for a manway or pumping shaft. In a few instances the shafts are 6 x 10 ft., having two compartments for hoisting and a smaller one for pumps. In such mines the double-skip system of hoisting is used. When the shaft reaches the solid rock, which consists of limestone or flint, the drilling begins. The prevailing method of placing and pointing the holes is shown in Fig. 1. There are 12 holes in the round, and so arranged that the rock to be lifted lies in the path of least resistance to the force of the powder. The four holes surrounding the middle of the shaft are known as sump holes and are inclined toward the center at an angle of 10 to 12 degrees from the perpendicular. They are put down 5 ft. deep and are designed to lift 4 ft. In each corner of the shaft, about a foot out, a hole is drilled, slanting slightly outward to a vertical depth of 5 to 6 ft. Holes are also drilled about a foot from the middle of each side also, slanting outward. This provides for the breaking of the shaft square. The sump holes are fired first, followed by the side holes, and last the corner holes. In starting a 6 x 8 ft. drift, the system of placing drill holes is practically the same as that used in shaft sinking, the same principles being utilized. When the drift is driven sufficiently to prevent the shaft from caving it is widened out to from 30 to 60 ft. In sheet ground the drifts are merely perfunctory passages between rows of pillars, which, owing to the stability of the roof, are from 30 to 55 ft. apart. In many of these sheet-ground mines, there are many acres undermined, with the roof only supported by intermittent pillars. Instances of 13 acres at one mine and 7 acres at another, show how large the horizontally bedded deposits sometimes are.

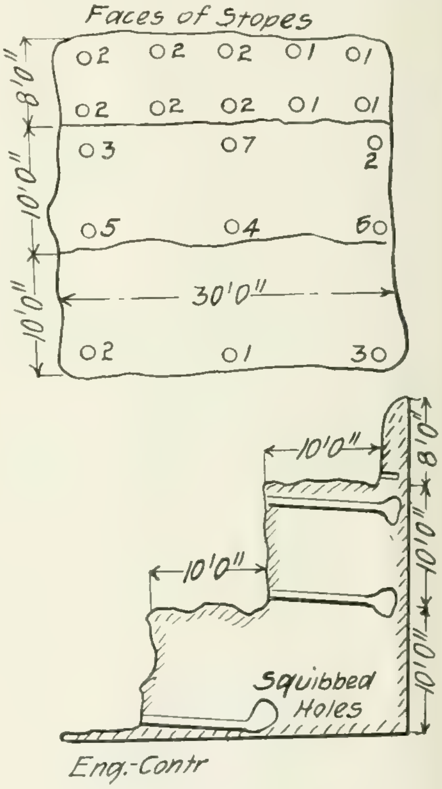


Fig. 2—Method of Stoping.

Where the ore deposit is only 8 ft. thick, as it often is, the drilling is a constant heading proposition. But if the deposit is in excess of 8 ft., it is worked by the stope system. An 8-ft. heading is carried along next to the roof, and the remainder of the deposit is worked in one or two stopes, according to whether it is less or more than 20 ft. in thickness. For example, if the ore body is 28 ft. thick, the whole is divided into an 8-ft. heading and two 10-ft. stopes. The heading and stopes are carried about 10 ft. ahead of the one next below. The practice under such conditions is highly efficient as to the quantity broken relative to the amount of drilling done and quantity of powder used.

Figure 2 shows the manner of placing and pointing the holes. The first four holes at one side of the heading are drilled 5 to 9 ft. deep, the others 7 to 10 ft. In the next round the shallower holes are drilled on the opposite side. The shallow holes are fired first. The holes drilled in the first stope are arranged in two rows of three holes each. The upper middle hole is fired first, then the upper corner holes, the lower middle hole, and the lower corner holes. The lower stope is broken by drilling three holes in a row along the floor. The middle is first fired, then the corner holes. The holes are numbered in the order they are fired.

All the holes in stope drilling, except those at the top which slant upward in order to follow the top of the ore deposit, are slanted downward at an angle of 8 to 10 degrees, so that they will hold the drilling water.

It will be noted that the work on the lower stope is less in proportion to the amount of rock broken. This makes possible a great reduction in the cost where the thickness of the ore body permits the working of three stopes.

In all headings the machines are mounted on columns while the stopes are worked by machines on tripods. Two or more drifts are worked by each machine so that the holes drilled each day can be squibbed, and the previous day's drilling fired as the men quit work. Thus the machines keep a day's drilling ahead of the shovelers.

With such conditions, one machine man and helper can drill a round of four holes, 8 to 10 ft. deep, in one 8-hr. shift, which allows for setting up the machines, squibbing and firing.

Returns to the U. S. Geological Survey representing 95 per cent of the Portland cement production of the United States for the year 1907, indicate that the total output of Portland cement in the last calendar year was approximately 48,000,000 bbls., as compared with 46,463,424 bbls. in 1906 and 35,258,812 bbls. in 1905.

The total excavation on the Isthmian Canal during March was 3,480,270 cu. yds. The highest previous monthly total was that of February, which was 2,945,880 cu. yds., or more than 500,000 cu. yds. less. Of the total March excavation 3,205,076 cu. yds. were taken from the canal prism—1,906,572 cu. yds. by steam shovel and 1,298,504 by dredges.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Ten Additional Letters Commending the American Society of Engineering Contractors.

In answer to editorials and invitations extended to engineers and contractors to apply for membership in this proposed society, Mr. Gillette has received scores of letters advocating the formation of such an organization.

Applications are coming in rapidly, the total number received being over 900. It would seem, therefore, that the permanent organization should soon be effected. An application blank can be found on page 14 of the advertising section. In our last issue we printed 12 letters commending the formation of this society; 10 additional letters received during the past week, follow:

Sir:

On March 13 last, I sent you my application for membership in the "Society of Engineering Contractors" and since then have induced several to make application.

The object of this letter is to add my endorsement to the suggestion made by several who have made application, viz., "that only engineers and contractors of 'standing' be admitted to membership."

The object of the society, as outlined by you, will be of great benefit, but applications for membership must be scrutinized carefully or the benefits accruing therefrom will be largely reduced. May I suggest that you give us your view of this phase of the organization. A letter in Engineering-Contracting, from you, will, in my opinion, do a great deal of good.

Yours very truly,
W. G. Smith,
Chief Engineer, Kenefick, Hoffman and Quigley, R. R. Contractors, Beaumont, Texas.

Sir:

I enclose herewith application for membership in the proposed American Society of Engineering Contractors, if my position as one of the engineers of "Sunnyside Yard" entitles me to such membership.

I wish the new society all success, as I believe there is a big need for such an organization and the need is growing greater from year to year.

Yours very truly, '
J. L. Ingle, Jr.,
Pa. Tunnel & Terminal R. R. Co.,
Woodside, L. I.

Sir:

Enclosed please find my application as charter member of the American Society of Engineering Contractors.

I have taken your magazine ever since its beginning and am very much interested in your ideas concerning the formation of such a society as you propose, and hope that it may meet with the greatest success.

Yours very truly,
Frank D. Brown,
Inspector, Grade Crossing Dep't, Erie R. R., Paterson, N. J.

Sir:

Please enroll me as a charter member of American Society of Engineering Contractors.

The idea of such a society appeals to me very much for I think there is a great need of such an organization.

Respectfully,
E. L. Bandy,
Isthmian Canal Com.,
Gatun, Canal Zone.

Sir:

Enclosed please find my application for membership in American Society of Engineering Contractors.

Yours truly,
W. A. Irwin,
United Railroads of San Francisco, Cal.

Sir:

I am sure that your idea of an organization of engineers-contractors will be appreciated by every member of the Guild who desires his business to advance with the other professions.

Yours very truly,
J. C. Slippy,
Consulting Tel. Eng.,
Waterloo, Ia.

Sir:

Enclosed please find application for membership in the American Society of Engineering Contractors, the aims and purposes of which are to be heartily commended.

The writer after several years' experience in engineering work, leading up to a position of responsibility, became engaged in the contracting field, which experience has enabled him to appreciate the need of just such a society as you propose.

There is much truth in the statement of a well known contractor that "No engineer should be placed in charge of construction who has not had at least two years' experience with a contractor." It has been the writer's experience that engineers have as a rule too one-sided an attitude in dealing with questions that may arise. This the writer believes is due chiefly to the unfair and archaic clauses generally to be found in engineering contracts and specifications, and any movement tending to bring about a better understanding between engineers and contractors relative to their mutual duties and responsibilities will be of great advantage to themselves and the public as well.

Respectfully yours,
M. Woolsey,
Supt. Walsh-Kahl Const. Co.,
Dalton, Mass.

Sir:

Enclosed you will find my application for charter membership in the American Society of Engineering Contractors.

As regards experience and qualifications I may fall short of requirements for membership but trust not.

Have been for the past year engineer on construction of a large coke plant near Brownsville, Pa., and for the three years previous was in the engineering and construction department of the Isthmian Canal Commission on the Isthmus of Panama. In any event, I wish you all success.

Yours truly,
F. W. Lyon, C. E.,
Washington, Pa.

Sir:

Enclosed please find my application for membership in American Society of Engineering Contractors subject to your approval and terms of the society. I desire to congratulate you on your efforts in this direction and think such a society will fill a long-felt want. Wishing the society every success.

Yours truly,
Ambrose Carthy,
R. R. Contractor,
Newberg Junc., N. B.

Sir:

Saw in the Engineering-Contracting a notice of the organization of the American Society of Engineer Contractors. If the organization is completed I would like to become one of the charter members provided the conditions of membership are satisfactory.

Yours truly,
Alva Baynes,
Omaha, Neb.

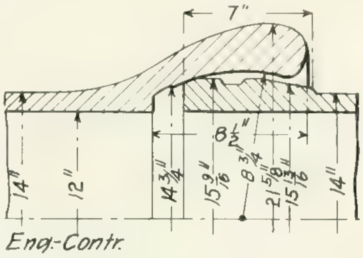
As showing the comparatively low prices that prevail throughout Montgomery County, Ohio, Mr. H. R. Klepinger, County Engineer, informs us that the county recently let a contract for macadamizing 5.81 miles of road, including 16,300 cu. yds. of excavation to be made, for $32,187. A contract for cleaning out a ditch requiring 18,000 cu. yds. of excavation (hand shovel work) was let at 10 cts. per cubic yard.

The average cost of cleaning brick streets at Rochester, N. Y., in 1906, was $16.49 per 1,000 sq. yds. The streets were cleaned an average of 37 times during the season.

The Method and Costs of Laying a Submerged 12-in. Water Main.*

BY J. CAUSLEY, C. E.

Capilano creek, which has been utilized by the city of Vancouver for a water supply, enters the Inlet at the First Narrows, or Lion's Gate (so named because it is overlooked by two peaks of the Cascades, which, from some points of view, greatly resemble two lions couchant), opposite Stanley Park, a government reserve northwest of the main part of Vancouver. A dam has been built on the Capilano 6⅛ miles from its mouth, the elevation of intake being 417 ft., and the water brought down in a 36-in. main to the line of the Inlet. From thence it is carried across the Narrows in submerged 12-in. mains placed on the bed of the Inlet, and through a 30-in. main to a pipe-head reservoir on a hill in the park which gives the reservoir an elevation of 219 ft. at the bottom and 245 ft. at the top. This reservoir was built in 1893, and holds about 11,000,000 gallons of water. From it the distributing mains run to the different parts of the city.



Sketch Showing Half Longitudinal Section of Pipe Joint.

During the past summer another dam has been built, three-fourths of a mile higher up the creek, the elevation of intake being 472 ft., with a 30-in. and a 22-in. main down to the old main.

There have been seven 12-in. mains placed across the Narrows at various times during the past 19 years. The last one has just been put in position, and of the method of accomplishing this the writer purposes giving a short description, trusting that it may prove of some interest, for the reason that it differed from the method usually followed (with variations to suit particular cases) in such work, viz., that of building a staging, or anchoring a string of rafts along the line to be followed, slinging the pipes over the position they are intended to occupy, jointing them up and lowering the connected line into place.

This method would not have been suitable in the cases under consideration on account of the water varying from 66 ft. deep at low tide to 75 ft. deep at ordinary high tide. The tide is very strong, running at speeds up to 8 knots per hour; also, and perhaps the most important of all, nearly the whole of the shipping trade of Vancouver, including ocean passenger and freight steamers, from 8,000 tons downwards, sailing ships towed in and out by tugs, coast steamers, rafts, coal barges, transfers towed by tugs, etc., passes through these Narrows. A system of hauling the pipes across was first put into practice by the Water Works Company, this system being greatly improved by the late City Engineer, Colonel Tracy, M. Can. Soc. C. E., and the Water Works staff.

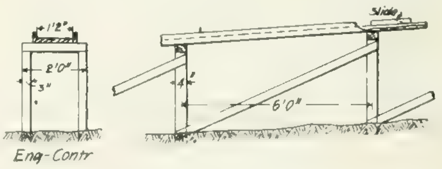
About three years ago it was intended to place another main across the Narrows, and in the early part of 1904 a contract was made with Messrs. Robertson, Godson & Co., of Toronto and Vancouver, for the supply of cast iron pipes for a submerged main, in accordance with the following specifications:

To be 12 ins. in diameter internally, 1 in. in thickness, lengths to lay 12 ft. each, of the best cast iron, strong, tough gray metal, cast vertically with the hub end down, the bell end to be bored spherically, and the spigot end to be turned where it fits in contact with the bored surface. To be tested to a pressure of 500 lbs. per sq. in. and hammered under pressure. To be coated with Dr. Angus Smith's preparation, or preferably with Wartz, Dove & Co.'s bitulithic solution.

The pipes were obtained from Stavely, near Glasgow, in Scotland, and weighed between 1,725 and 1,800 lbs. each.

The half section at a flexible joint shows the latest form of the bell and spigot of a pipe. The shape of the bell has been altered from that of the earlier forms to cause the pipes to offer as little resistance as possible in sliding along the bed of the Inlet.

The pipes were delivered at Vancouver in August, 1905, but it was not convenient to place them in position till the latter part of 1906, when it was decided that they should be laid directly by the city, under the superintendence of Mr. S. Maddison, the manager of the water works, who had had much experience in the work of laying previous mains. Captain Westcott, who was contractor for laying two of the previous mains, and foreman on laying the steel main, was engaged as foreman of the work. This main was to take the place of No. 3 pipe line, the pipes of which were taken apart by a diver and brought to the bank.



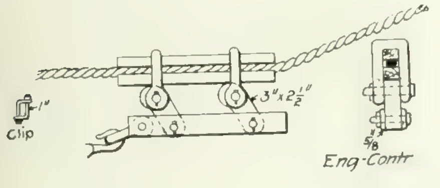
Sketch of Chute.

A chute was constructed of 14-in. x 2-in. dressed plank, with 4-in. x 1-in. battens on each side—i. e., projecting 2 ins. above the plank—supported at every 6 ft. by cross pieces of 3-in. x 4-in. quartering.

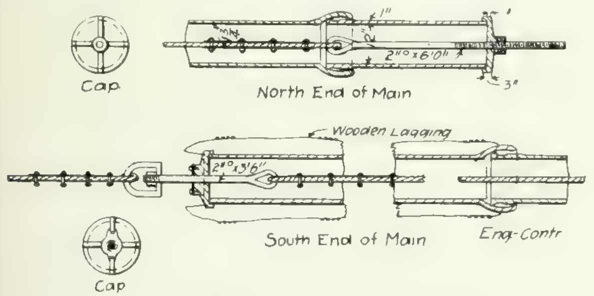
---

*Abstracted from a paper read before the Canadian Society of Civil Engineers, Feb. 20, 1908.

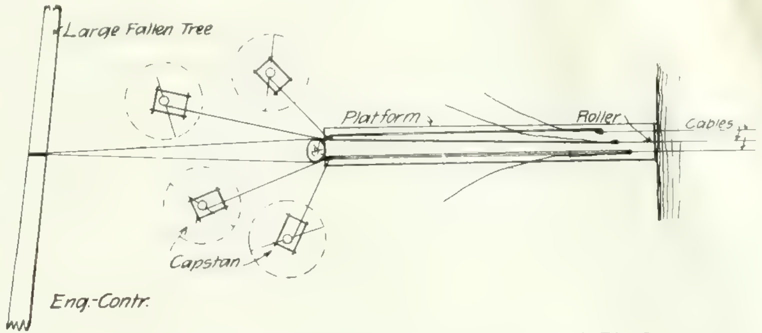
each on 2 posts of 3 in. x 4 in. (see sketch), from low water on the north side of the Narrows extending back the length of the main. Each length of pipe was tested separately under a pressure of 350 lbs. to the square inch. The pipes were then placed on the chute spigot ends to the south, with a piece of 14-in. x 2-in. plank, about 2 ft. long, on the bed of the chute running between the side battens under each pipe at the bell end. The piece of plank was notched out at the top side and upper end, so as to go under, support, and steady the bell, and keep the pipe in the center of the chute. The under sides of these blocks were well greased. The spigot of each pipe was pressed home in the bell of the next one, lead run in and calked to make a tight joint. No gaskets were used, as the bells and spigots were bored and turned to make tight and flexible joints. Each joint required from 60 to 70 lbs. of lead, making about 3½ tons of lead used in all. The pipes, after being put together and jointed, were tested collectively under a pressure of 150 lbs. per square inch.



Sketch Showing Arrangement of Gripper.



Arrangement of Hauling Cables



Sketch Showing Arrangement of Capstans and Platform.

A line was pushed through the pipes with a rod made of a number of long slats of wood nailed together and a 1¾-in. steel wire cable hauled through them.

Over the lower or south end of the string of pipes a cast iron cap 1 in. thick, with strengthening ridges on the outer side, and flange overlapping the end of the pipe, was placed, leaded, and calked. This cap had a 2-in. circular hole in the center with a stuffing-box. Through this was passed a 2-in. turned rod 3 ft. 6 ins. long, and the hemp packing was well tightened up around it. On the inner end of the rod was an eye through which the end of the 1¾-in. steel wire cable, which went through the line of pipes, was passed, doubled back on the cable, and secured with four clips. The outer end of the eye-bar, on which a screw thread was cut, went through a stirrup-shaped ring and was made fast to it with two nuts. To this stirrup one of the hauling cables was attached and secured in the same manner as the cable inside the pipes was secured to the other end of the bar. By these means the cable had no tension on the front end of the string of pipes.

The end length of pipe carrying the cap, etc., was covered with a wooden lagging, bound at three places with ⅜-in. wire rope. The sketch readily explains the arrangements made.

The cable on the west side of the pipes was attached to the 40th pipe by taking two turns round the pipe, bringing the end back to the cable, and fastening it with 4 clips. The cable on the east side of the pipes was secured to the 13th pipe by means of a chain, which had a round turn round the pipe, and the ends made fast to the cable with clips. Iron bands were put round the pipe and cables fastened at intervals to enable a fair pull to be taken.

On the upper, or north end of the pipe a cap similar to the one at the south end was placed, with the exception that the 2-in. circular hole in the center was through a plain boss. A 2-in. round bar passed through this hole. The inner end of this bar had an eye to which the cable through the pipes was attached in the same way as the other end of the cable was fastened to the bar through the cap at the south end of the pipes. On the outer end of this bar a screw thread was cut, and the cable through the pipes was tightened up with a nut. A second nut was placed above the first one for the sake of security. A length of 12-in. pipe, 4 ft. long, was fitted into the bell of the last pipe for the flange of the cap to fit on to. The whole was leaded and thoroughly calked. This was completed on Aug. 19.

It had taken about a month to do this work, with a gang of about seven men, under the superintendence of Captain Westcott. There were 109 12-in. pipes, making 1,308 ft. of pipes, whose weight varied from 1,725 lbs. to 1,800 lbs. each, giving a total weight of about 96.05 tons. Including lead caps, internal cable, etc., the total weight would be about 102½ tons.

1,800 ft., 1½ ins. diameter, and 1,800 ft., 1¼ ins. diameter, fresh steel-wire cables had been bought in Nanaimo, a coal mining town across the Gulf of Georgia. These cables were not new, but had been used for hoisting in the mines. Also four new 6-in. (circumference) 120 fathom Manila ropes had been purchased at $160.00 each, for tackle. Six new 3-sheave blocks and two new single-sheave blocks had been made in the water works shops. The cables, on their reels, had been taken across to the north shore of the Narrows.

The end of a line was taken across, attached to the end of one of the cables, and the cable was hauled across, a snatch block and four horses being used. No power tackle was used, as the hauling had to be done in the space of about 15 minutes at slack water.

One cable was hauled across at slack water on Aug. 15, one on the 18th, and one on the 19th. By Aug. 23 everything was ready to begin hauling. The cables had been examined by the diver and tightened up with their blocks and tackles.

To each of two of the cables was attached a tackle consisting of a pair of 3-sheave blocks with one of the 120 fathom 6-in. Manila ropes rove through them worked by a capstan to each tackle driven by one or two horses. The other cable had two tackles, with a pair of 3-sheave blocks attached to each tackle, each tackle worked by a capstan. The drum of the capstan was 18 ins. in diameter, and the lever arms 11 ft. each. The cable, however, with the two tackles attached, had been left taut too long; the flood tide caught it and carried it up channel about 100 ft. at the center, drawing two lengths of pipe slightly out of line before it could be loosened. It was necessary to draw it back to the north side and haul it across afresh. This had been done by Aug. 25, and everything found to be in order. Passing vessels had caused some inconvenience when getting the lines across.

Monday, August 27.—Hauling began at mid-day at low water with four horses, i. e., one at each capstan, and was also continued on the slack water in the evening, lasting altogether about five hours, and moving the main about 178 ft. The work could not be carried on longer as the tide when stronger would have caught the cables and carried them out of line. After the first hauling the manager went down in diving dress, examined the pipes that had moved, found that they had been drawn straight, and that the joints were uninjured.

Tuesday, August 28.—Hauling was carried on from noon to 2 p. m., and from 5 to 8 p. m. The main was hauled 194 ft.; in all, 372 ft. Four horses had been used, i. e., one at each capstan.

Wednesday, August 29.—Up to 7 p. m., only about 35 ft. had been hauled. [illegible] horses had been doubled on two capstans and had not pulled well together; the tide also had not served well. Hauling was carried [illegible] .10 to 7:30 p. m., when it was stopped by a signal from the other side (the light put out). It was found that one side of the chute had sunk where swampy ground was crossed, and that the pipes were slipping off. About 78 ft. had been hauled; in all 450 ft.

Thursday, August 30.—The chute was strengthened early in the day. In the morning the tide was not favorable for hauling, which was not begun till about 6:30 p. m. Only one capstan was doubled till about 9:30 p. m., when a second horse was put on No. 1 capstan. Hauling was stopped about 1 a. m., as the horses were unable to work longer. About 300 ft. had been hauled; in all 750 ft.

Friday, August 31.—In the morning the pipe was examined by the diver, who went right along the part under water from end to end, and found everything in good order. There is a soft shingle bank extending from the north side to within about five hundred feet from the south side of the Narrows, and the pipes had poughed into this for a depth of about two feet and moved boulders that were in their way. Further south the bottom is a sandy hardpan.

Hauling began about 5 p. m., and one fleet (the length of travel of the moving blocks, about 75 ft.) was hauled by about 7 p. m. The tackles were then overhauled. Hauling was continued again from about 8 to 8:20 p. m., when the gripper on the eastern cable gave way. It was got in order again and operations were continued. About 12:30 a. m., the central cable slipped in the gripper and work was suspended for the night. About 150 ft. hauled; in all 900 ft.

The pull was now becoming heavier.

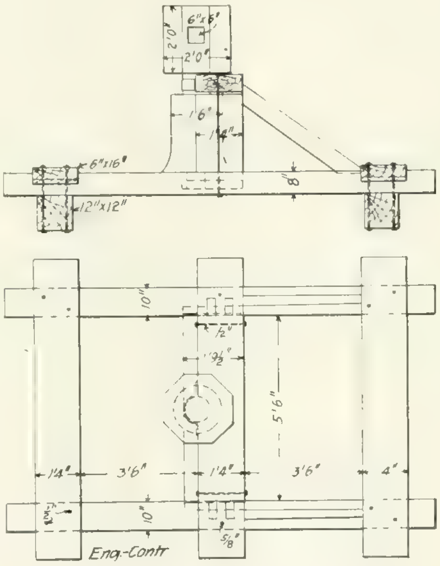
Saturday, September 1.—The diver went down in the morning and found everything in god shape.

Hauling began about 4:30 p. m. The pipe would not start at once, and the gripper on the central cable (No. 1 capstan) slipped at about 4:45 p. m. It had to be loosened and a fresh grip taken, when the pipe was started. The fleet was finished at 6:15 p. m. It was found from measurement that 162 ft. still required to be hauled. The tackles were overhauled; a sheave in one of the blocks, which was found to be cutting (the hole had become enlarged about ¼ in.) was replaced by another, and hauling was begun again about 7:45 p. m. About 9 p. m. it was found that the head of No. 2 capstan was giving way, and work had to be suspended till a new drum could be made, 169 ft. were hauled; in all 1069 ft. 155 ft. remained to be hauled.

Monday, September 3.—A new capstan barrel had been made and placed in position, and hauling was begun at 8:15 a. m. The main was moved about 40 ft., but the tide was found to be running out too strongly, and work was stopped. The pull had become very heavy, as so much of the main was on the ground and part of it was coming up hill. Six horses were used this day, viz., two each on Nos. 1 and 2 capstans, and one each on Nos. 3 and 4.

Hauling was begun again at 11:10 a. m. A gripper slipped soon after starting. A fresh pin was put in and tightened up, and hauling was continued. Before long the rope of the tackle of No. 2 capstan got under the barrel of the capstan and had to be cleared. The fleet was finished at 12:25 p. m. Seventy feet still required to be hauled.

The tackle was overhauled and work begun again at 1 p. m. The rope got under the barrel of No. 2 capstan again and had to be cleared. The hauling was heavy, but the pipe moved steadily. The work was finished at 2:45 p. m., the front end of the pipe being above low water. Total distance hauled, 1,224 ft.



Plan and Side Elevation of Capstan.

The main was tested on September 5, under a pressure of 125 lbs. per sq. in., and found to be perfectly tight.

Captain Westcott employed 11 men during hauling, as well as the diver and the drivers of the teams.

Four hundred feet of pipe were afterwards laid on the north side of the Narrows to extend the main to the valve chamber there, and 150 ft. on the south side to the valve chamber at the south bank in the ordinary manner.

Cost of pipes:

109 12-ft. lengths 12-in. pipe = 1,308 ft.

109 lengths, 1,725 lbs. to 1,800 lbs. each, average 1,762.5 each.

=192,112 lbs.

=965.05 tons, at $40.00 per ton at C. P. R. wharf	=$3,842.00
Removing to north shore of Inlet	200.00
Total	$4,042.00

Expenses connected with hauling, etc.:

Labor, as per pay rolls July 2 to August 11, for building chute and platform, putting up capstans, placing and jointing up pipes, etc	$1,002.69
Labor, hauling the main, August 25 to September 8	1,163.23
Total labor	$2,165.92*

*This amount includes 8 horses, 7 days at $8.00 per team and man per day, say with overtime, $10.00	$280.00
4 horses 3 days	48.00
	$328.00

General wages 25 to 30 cents per hour; Overtime, time and a half.
Diver $15.00 per day.

Materials used, cartage, haulage, provisions and incidental expenses charged to the new main and taking up the old one were:

To old main	$ 974.83
To new main	1,458.76
	$2,433.59

Fresh plant bought:

4-6-in. (circumference) 120 fathom Manila ropes, at $160 each	$640
2,000 ft. ⅝-in. steel wire rope, at 7 cts. per ft.	140
2,800 ft 1½-in. and 1⅜-in steel wire cable (not new).	150
	$ 930.00

Total for materials, incidental expenses, etc., in present work by subtracting fresh plant bought in order to give current expenses	$1,503.59
Less taking up old main account.	403.59
Total for materials used, incidental expenses, etc., in hauling, placing, jointing up, etc., of new main	1,100.00*

*This amount includes—Lead	$431.93
8.040 ft. lumber dressed one side for chute, at $18.00 per thousand	144.72
2 kegs nails	8.00
2,436 ft. lumber for platform, at $17.00 per thousand	41.41
1 keg nails	4.00
	$630.06

Also charged to the new main, on September 22, for labor for laying, jointing, etc., the pipes above low water to the valve chambers	$ 662.28
Amount charged to labor for taking up the old main and bringing the pipes to the shore	1.652.77
To which add the amount for materials and curernt expenses shown above	403.59
Total	$2,056.36

Methods and Costs; Some Old; Some New.

Protecting Water Pipes from Freezing.—Experience in several New England cities, where it has been necessary to carry water mains over streams on bridges, has shown that the best method of protecting the pipe from freezing is to cover it with double boxing, leaving an air space between the two. In one case at New Bedford, Mass., a 6 in. main was laid upon a platform passage way suspended from a bridge beneath the floor, and the pipe covered with double boxing, with an air space between. This was done in 1902, and no trouble has since been experienced from freezing.

Data on a Sand-Clay Road.—The road was constructed at Gainesville, Fla., under the supervision of the U. S. Office of Public Roads. It was one mile long, 14 ft. wide and had a sand-clay surface 10 in. thick at the crown and 8 in. thick at the sides. The clay was taken from Station O. and hauled to Station 30, beyond that latter station it was hauled from a clay pit ¾-mile distant. The clay was placed upon the road and covered with sand and mixed by a disc harrow, finally being rolled with a 3-ton horse roller. The cost of the road was $881.25, or about 10 cts. per square yard. The above cost included the following: Teams and drivers, $465; laborers, $365; foremen, $40. Wages were about $3 for teams and $1.25 for labor, per 10-hour day.

Tests of Creosote Oil for Paving Blocks.—The city of Minneapolis, Minn., has in service over 200,000 sq. yds. of creosoted wooden block pavement. The specifications of the city for creosoted paving material require an impregnation of 16 lbs. per cubic foot, with creosote oil, as follows: The specific gravity of the oil, at 20° C., shall be at least 1.09. The oil shall be completely liquid at 25° C., and show no deposit on cooling to 22° C. It shall not contain more than 2 per cent of water nor more than 3 per cent of matter insoluble in absolute alcohol or benzene. The distillation test is as follows: 100 grams of oil shall be placed in an 8 ounce retort, fitted with a thermometer, the bottom of whose bulb shall be placed ½ in. above the oil and not moved during the test. The discharge opening of the retort shall be from 20 to 24 ins. from the bulb of the thermometer, and the retort shall be covered to prevent too rapid radiation. The percentages are for dry oil, and by weight: Up to 150° C., nothing must come off; up to 170° C., 2 per cent; up to 210° C., from 6 per cent to 8 per cent; up to 235° C., from 20 per cent to 30 per cent; up to 315° C., from 40 per cent to 50 per cent; up to 350° C., from 60 per cent to 80 per cent. Distillation shall be gradual, and be completed, up to 315° C., in 30 minutes from the first drop, and entirely completed in 40 minutes.

Estimated Cost of Producing Ties.—In a paper read before the Engineers' Club of Philadelphia, and printed in the proceedings of that society, Mr. E. A. Sterling, Forester of the Pennsylvania Lines, stated that in their work on the Pennsylvania Lines east of Pittsburg, and Erie, over 2,000,000 trees had been planted on lands acquired in connection with widening and straightening the main line, and in the construction of low grade lines. The actual cost of plant material and planting last spring was $11.29 per thousand. Mr. Sterling gave the following as an estimate of the returns per acre, which may be expected from such work, if red oak is planted on land valued at $10 per acre, with interest at 4½ per cent, compounded annually, and the crop maturing in 40 years:

Cost of land at $10, at 4½ per cent, for 40 years	$ 58.16
Cost of plant material and planting $10, at 4½ per cent for 40 years	58.16
Taxes 3 cts. per annum at 4½ per cent for 40 years	3.21
Management and protection, 15 cts. at 4½ per cent for 40 years	16.05
Cost of sawing or hewing 400 ties at 10 cts.	40.00
Cost of hauling 400 ties at 5 cts.	20.00
Total	$195.58

By the above estimate 400 ties would be produced per acre every 40 years at a cost of 48 cts. each, including compound interest charges at 4½ per cent. Mr. Sterling states that the estimate of 40 years will hold for red oak and Scotch and red pines; while chestnut should make ties in 30 to 35 years and locust in 25 to 30 years, if not eaten up by the borers. The trees at the end of this period should average 15 ins. on the stump. The tax rate of 3 cts. per acre, used above, is far below the present rate, but is what would be considered a fair charge in a European forest.

Cost of Two Small Surveying Jobs.—The first job consisted of a transit traverse up Town and Hanging Kettle Creeks in Clay county, Miss., the work being done in November, 1907. A summary of the work is as follows:

Number courses Town Creek	34
Total distance	1.97 miles (10,415.4 ft.)
No. courses Hanging Kettle Creek	19
Total distance	126 miles (6,629.3 ft.)
Number of courses in both creeks	53
Dist., both creeks	3.23 miles (17,044 ft.)
Average course	321.7 ft.

In the field work 3½ days were spent; while the office work, computing and mapping was 6 days. The working day was 9 hours. The cost of the field work was as follows:

Instrument man at $5	$17.50
Two chainmen at $1	7.00
Two rodmen at $1	7.00
One axman at $1	3.50
Total, 3½ days	$35.00

The office work cost $30; a draftsman and computer at $5 being employed for 6 days. The total cost was, therefore, $65.00, and the cost per mile was $20.12. The 1/16 section, ¼ section and section lines had been run across creeks, and ties were made to all such lines. All lines were run with transit and steel tape and all angles and lines checked before areas were computed. The map shows the acreage on each side of center line of creek in each 1/16 section (40 acres) crossed. The traverse was made on one bank, the creek being too deep to cross. The country was flat with scattering woods and bushes. The second job consisted of the survey of a convict farm in Mississippi, for a lumber company, the work being done during January, 1908; a summary of the work is as follows:

Cultivated land:

Number cuts	58
Smallest acreage per cent	5 acres
Largest acreage per cent	16.54 acres
Total acreage	414.77 acres
Average acreage per cut	7.15 acres

The time in the field was 3½ days, and the time in office, computing and mapping, was 5 days; an 8-hour day was worked. The cost of the field work was as follows:

Surveyor, at $5	$17.50
Four helpers, at $1	14.00
Total, 3½ days	$31.50

The office work cost $25, a draftsman being employed for 5 days at $5 per day. The total cost was, therefore, $56.50, or 13.5 cts. per acre. For the above information we are indebted to Mr. Charles L. Wood, C. E.

The cost of cleaning asphalt streets by day labor at Rochester, N. Y., in 1906, was $33.11 per 1,000 sq. yds. for the season. The asphalt streets were cleaned on an average of 101 times during the season.

A blast of 19½ tons of 45 per cent dynamite fired on March 20, in the Isthmian Canal prism at Caimito, broke up 70,769 cu. yds. of material. The charge was placed in 25 holes, ranging in depth from 35 ft. to 90 ft., the average depth being 60 ft.

Returns received by the U. S. Geological Survey for iron ore produced in the year 1907, while not complete, indicate that the total production for the year will fall between 52,000,000 and 54,000,000 long tons. The total production of 1906 was 47,749,728 long tons.

Catalogs Worth Having

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting.* If [illegible] in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0675. **Concrete Mixers.**—Nuss Concrete Machinery, Philadelphia, N. Y.

The mixer described in this 14-page pamphlet is a double tube mixer, one tube being let into the other so as to form a continuous vessel for the batch. The tubes are cast into one piece. The mixer is designed to be fed by belt conveyor from an automatic measuring and proportioning hopper mounted separately on trucks. Claim is made that a mixer running out 60 cu. yds. per hour can be operated by a 5 H. P. engine. The machine is an interesting one and contractors should investigate it.

No. 0676. **Roller Bearings.**—Hyatt Roller Bearing Co., Newark, N. J.

A 24-page pamphlet telling of the use of roller bearings for machinery, cars and trucks. The efficiency of the machines is increased by such bearings, as there is less friction and the bearing is more easily lubricated, preventing wear. These bearings have been standardized and are now kept in stock in the company's various sales rooms. The bulletin gives rules for calculating safe loads to be put on various sizes of bearings, and tables to show size of bearings to use for different speeds.

No. 0677. **Mechanical Rubber Goods.**—Mulconroy Co., 722 Arch St., Philadelphia, Pa.

A 16-page pamphlet describing steam drill, air and water hose, and hose couplings. Also rubber and leather belting, sheet packing, gaskets, pump diaphragms, and piston packing. Oil cloth clothing for hard usage is listed, and a boot for construction work that is waterproof. This boot is of rubber with a leather sole, allowing men to use it where rubber soles would be useless.

No. 0678. **Hains Concrete Machinery.**—The Hains Concrete Mixer Co., 723 Union Trust Bldg., Washington, D. C.

A 24-page catalog describing and illustrating the Hains automatic concrete mixer and explaining the simple principle on which the machine works. Photographic reproduction of structures built with the Hains are shown and the catalog contains a number of sketches showing different arrangements of plants using the Hains mixer.

No. 0679. **Pocket Transit.**—Taylor Instrument Companies, Rochester, N. Y.

A 4-page leaflet telling of the good points of the Verschoyle Pocket Transit. With this light and compact instrument both the horizontal and vertical angle can be read at one time. An excellent instrument for mine work.

No. 0680. **Petrolithic Pavement.**—Petrolithic Pavement Co., 764 Pacific Electric Bldg., Los Angeles, Cal.

This is a well printed and beautifully illustrated catalog, just off the press, and it shows the wonderful success of petrolithic pavements in California where they have been used for residence streets and roads, as well as on business streets where traffic is heavy. Instructions and specifications for laying this pavement are given, and all the tools needed are likewise described. The petrolithic tamping roller, the oil heater, and oil spreader, the harrow and clod breaker are all illustrated. The pavement consists of any natural soil sprinkled with asphaltic oil, or other suitable bituminous liquid, then harrowed and finally tamped solid with a roller provided with tampers projecting from its periphery.

No. 6081. **Corrugated Bars.**—Expanded Metal & Corrugated Bar Co., Frisco Bldg., St. Louis, Mo.

A 112-page catalog setting forth the merits of both the square and round bar for reinforcing concrete manufactured by this company. The various sizes of the bars are illustrated. Plans of reinforcing buildings and other structures are shown. The book is embellished with many photographic reproductions of buildings in which these bars have been used.

No. 0682. **Sluice Gates.**—Coldwell-Wilcox Co., Newburgh, N. Y.

A 20-page catalog telling of the various water works appliances manufactured by this company. Their sluice gates are of all sizes and styles, with dimensions given, so designers can adapt their outlets to these gates. Pedestals and machinery for opening and closing the gates are also shown, likewise flexible pipe joints.

No. 0683. **Concrete Mixers.**—Svenson-Shuman Machine Co., Pittsburg, Pa.

The Svenson concrete mixer described in this 16-page pamphlet is a continuous mixer with automatic measuring and charging hoppers. A feature of this mixer is a continuous shaft carrying a tapered screw conveyor and mixing puddler and which both proportions the materials and mixes them. Especial simplicity of operating mechanism is claimed.

No. 0684. **Locomotive Repair Parts.**—Davenport Locomotive Works, Davenport, Ia.

This 40-page pamphlet is a guide and book of directions for ordering repair parts for Davenport contractors' locomotives. The arrangement is particularly convenient. On each left-hand page is grouped outline sketches of a number of parts each bearing a number; the facing page carries a list of names of these parts with the code word for ordering. Every user of a Davenport locomotive should have this pamphlet.

No. 0685. **Centrifugal Pumps, Gasoline and Steam Engines.**—Erie Pump & Engine Co., Erie, Pa.

This 36-page catalog lists the above named company's complete line of centrifugal pumps, gas, gasoline and steam engines. Several combination outfits are shown which should be of interest to contractors. One of these consists of a four-stage turbine pump direct connected to a gasoline engine which has proved particularly desirable for isolated plants.

No. 0686. **Blocks.**—W. W. Patterson Co., Pittsburg, Pa.

This 40-page pamphlet describes and illustrates the full line of standard blocks made by the company named. The articles listed also include ratchets, self-oiling sheaves and lateral brace snatch blocks.

No. 0687. **Valves and Hydrants.**—Pittsburg Mfg. Co., Pittsburg, Pa.

This 64-page pamphlet lists the various sizes of single and double gate valves, sluice gates and hydrants made by the company named. The several types of valves are described in detail. There are some dozen or more pages of tables, formulas and useful information for water-works and city engineers.

No. 0688. **Steel Centering for Concrete Structures.**—Blaw Collapsible Steel Centering Co., Pittsburg, Pa.

The text pages of this 58-page pamphlet describe briefly the advantages of sectional steel centers for sewers, tunnels, arch culverts, etc. In addition illustrations are given of a remarkable variety of conduit work in which Blaw centers have been used. The pamphlet is worth careful examination.

No. 0689. **Concrete Mixer.**—Fillmore Machinery Co., Fillmore, N. Y.

The mixer described in this 31-page pamphlet is a continuous, proportioning mixer. A feature of the mixer is the shape of the mixing blocks on the rotating shaft. This is such that the material is shifted backward and forward while being moved along the mixer drum.

No. 0690. **The Making of Artificial Stone.**—The Century Cement Machine Co., Rochester, N. Y.

This 22-page pamphlet gives in brief form directions for making concrete blocks. It includes instructions for selecting and proportioning materials, molding and curing, giving many useful hints and details.

No. 0691. **Bay State Brick and Cement Coating.**—Wadsworth, Howland and Co., Boston, Mass.

The coating discussed in this 40-page pamphlet is "composed of a cement base held in suspension by a volatile oil which evaporates on application." Directions are given for specifying and for using the coating and numerous structures in which the coating has been used are illustrated.

No. 0692. **Watson Dumping Wagons.**—Watson Wagon Co., Canastota, N. Y.

This 16-page pamphlet gives an interesting bit of history of the development of the Watson dumping wagon beginning with the first wagon built in 1887. The growth of the works from the barn in which this first wagon was constructed to the present factory occupying 115,000 sq. ft. of floor space is shown. The bulk of the pamphlet describes the present models of Watson wagons in some detail, and gives dimensions, capacities and prices.

No. 0693. **Utica Hydraulic Cement.**—Meacham & Wright, Chicago, Ill.

This 16-page pamphlet schedules the results of a dozen or so of tests of Utica hydraulic cement.

No. 0694. **Automatic Tamper for Concrete Blocks.**—Kramer Automatic Tamper Co., Peoria, Ill.

This 32-page pamphlet describes in some detail the construction and the operation of a power tamping machine for making concrete blocks. Outputs are given and comparisons of cost made with hand tamping. The machine will tamp whole blocks or fractional blocks equally well.

Personals.

The Electric Welding Co. has moved its offices from 4 Smithfield St. to 316 Fourth Ave., Pittsburg, Pa.

George Foster, a contractor, was instantly killed last week by a railroad engine at Crafton, Pa.

Mr. Robert A. Cummings, M. Am. Soc. C. E., has moved his offices from 4 Smithfield St. to 316 Fourth Ave., Pittsburg, Pa.

First Lieut. Charles T. Leeds, Corps of Engineers, U. S. A., has been transferred from Fort Bayard, N. Mex., to Los Angeles, Cal.

Mr. Y. Hammano, Chief Engineer of the water works at Formosa, Japan, is now in this country inspecting sewage purification plants and water filtration systems.

Mr. George F. Birge, Superintendent of Streets of Northampton, Mass., was shot and fatally wounded last week by a discharged employe of the Street Department.

The offices of the Lehigh Valley Testing Laboratory have been removed from 4 Smithfield St. to 316 Fourth Ave., Pittsburg, Pa.

Mr. Charles T. Waring has been appointed assistant engineer in charge of Culebra Station, Division of Municipal Engineering, Isthmian Canal, vice Mr. Geo. H. Ruggles, transferred.

Mr. D. W. Church, Assistant Engineer in charge of the Designing Department of the City Engineer's office of Chicago, Ill., has been appointed Principal Assistant Engineer of that office.

Mr. Munson Nichols, 35 Hamilton Ave., New Brighton, S. I., New York, has been appointed an assistant engineer in the Bureau of Engineering-Topography of Richmond Borough.

First Lieut. Robert R. Ralston, Corps of Engineers, U. S. A., heretofore on duty at Washington Barracks, D. C., has been transferred to the office of the Chief of Engineers, U. S. A.

Messrs. A. A. Hamilton, D. S. Huffman, J. R. Pinn, James Bambridge and A. S. Fleming have organized the Hamilton-Huffman Construction Co., of Fairmont, W. Va., and will engage in a general contracting business.

Mr. Fred K. Potter, for many years connected with the Capell Fan Engineering Co., has been appointed manager in the Pittsburg district for the Sirocco Engineering Co. His offices will be in the Keenan Bldg., Pittsburg.

Mr. V. E. McBee, for the past nine years assistant engineer of the Seaboard Air Line Ry., has resigned his position with that road and will engage in an engineering and general contracting business at Birmingham, Ala.

Maj. William E. Craighill, Corps of Engineers, U. S. A., heretofore Engineer of the Seventh and Eighth Light House Districts, has been ordered to Baltimore, Md., to relieve Col. Richard L. Hoxie, Corps of Engineers, in charge of the fortification and river and harbor works around Baltimore.

Mr. J. E. Greiner has resigned his position as Assistant Chief Engineer of the Baltimore & Ohio R. R., and will engage in a consulting engineering practice with offices in Baltimore, New York and Chicago. He has been retained by the Chicago, Burlington & Quincy Ry. as Consulting Bridge Engineer and will also serve the Baltimore & Ohio R. R. in an advisory capacity.

Mr. James D. Schuyler, of Los Angeles, Cal., the well known hydraulic engineer, has been awarded the Thomas Fitch Rowland Prize for 1907 by the American Society of Civil Engineers for his paper entitled "Recent Practice in Hydraulic-Fill Dam Construction." Mr. Schuyler has the distinction of being the first member of the profession to twice receive this prize, it having been awarded to him once before for his paper "The Construction of the Sweetwater Dam."

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
(NOT INC.)
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . MANAGER
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):— ***$2.00*** *a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*

$2.50 *a year (52 issues) to Dominion of Canada.*

$3.00 *a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:
Practical Service of the College Testing Laboratory . . . 243
CONCRETE SECTION:
Tests of Cast Iron and Reinforced Concrete Culvert Pipe............244
Reinforced Concrete Caisson Breakwater at Algoma Harbor, Wis.....246
Cost of Two-Story Reinforced Concrete Factory Building............247
EARTH AND ROCK SECTION:
Cost of Diamond Drilling in Mexico..248
The Cost of Spreading Earth in Rolled Embankments 249
GENERAL ARTICLES
Some Economic Advantages of Large Size Drain Tile..................250
Characteristics of Wire Rope Tramways with Some Figures on Cost of Operation 253
METHODS AND COSTS:
Adobe Road Construction in California—Cost of Repairs of Steel and Wood Cars—Reinforced Concrete Slab Over Refilled Trenches—Road Construction in Gumbo Soil—Tree Planting by the Massachusetts Highway Commission 252
CATALOGS WORTH HAVING . . 254
PERSONALS 254

Practical Service of the College Testing Laboratory.

Professor Talbot's paper on tests of cast iron and reinforced concrete culvert pipe, the second instalment of which is printed in this issue, is deserving of particular mention. The paper is unique. So far as we know it is the only investigation and discussion of culvert pipes on such broad lines ever undertaken. The paper is also distinctly practical in character. The tests are thoughtful attempts to get working tests and the discussion has a distinctly practical turn. We mention these things here not so much to impress the practical value of this particular paper as to show how the nature and purpose of college testing laboratory work is changing. The modern college testing laboratory is becoming a distinct power in the service of the practicing engineer.

This statement demands some development, for it asserts a radical change from the conditions that most of us have considered to exist. The college testing laboratory is still making its specimen tests and conducting its purely scientific investigations, but it is also carrying on working tests and examinations in great variety and number. To see this we have only to review briefly the engineering laboratory work of Professor Talbot's college alone. This laboratory is selected not because its work is unique but because it is representative of that of a score of college laboratories throughout this country. Wisconsin, Michigan, Iowa, Cornell, Purdue and Pennsylvania are others that can be named in the same breath.

Since its start in 1904 the Illinois engineering experiment station has conducted one of the most thorough and comprehensive studies of full size concrete beam and column tests ever undertaken. The results of these tests are being made use of by every designer of reinforced concrete. The laboratory has similarly investigated the value of high-speed tool steels, the resistance of tubes to collapse, the holding power of railroad spikes, the fuel value, weathering qualities and smokeless combustion of Illinois coals, the effect of scale on the transmission of heat through locomotive boiler tubes, the economy of roof truss design, the strength of chains, the comparative service of electric lamps and finally the strength of culvert pipes. This is not a complete list but it is ample to indicate the practical nature of the work being done.

The paper on culvert pipe tests exemplifies very clearly the nature of all those investigations. They are practical working investigations for the service of the practicing engineer. Naturally they reflect the limitations of the laboratory and to some extent the notions of the teacher and student in distinction to the engineer actually engaged in design and construction, but they are of unquestionable service.

As we have stated above the work being done by this one college laboratory is representative of the work being done by the laboratories of colleges all over the country. It is a work which deserves the cheerful and energetic support of every practicing engineer. They should give this support. We know that the colleges will welcome it and will make every use possible of suggestions, advice and criticism from practicing engineers.

The following table, compiled by the Forest Service, U. S. Department of Agriculture, shows the expenditures and revenues of national forests of several countries:

Country	Total net revenue from Government forests	Expenditure per acre	Net revenue per acre
Wurttemberg	$3,098,128	$2.05	$6.60
Saxony	2,299,000	3.00	5.30
Baden	829,162	3.58	4.42
Hesse	744,209	1.25	4.29
Switzerland	237,663	1.32	2.55
Prussia	17,054,144	1.58	2.50
Bavaria	5,128,348	1.99	2.22
France	4,737,250	.95	1.75
Italy	....	....	.33
Hungary	....	.34	.32
Austria	5,313,000	.56	.24
Roumania	182,600	.	.18
Spain	....	....	.17
Sweden	1,677,672	.02	.09
Russia	21,500,000	.01	.032
United States	*2,412,000	.007	‡.0001
United States	†128,659	.0093	.00086

*1905-6 †1906-7 ‡Deficit

A railroad projected, financed and built by farmers living along the line is something of a novelty. Such a railroad was opened for traffic in Iowa this year. It is 17 miles long, and the rolling stock consists of one engine and several freight cars and coaches. The road bed is unballasted and it takes 1½ hours to cover the 17 miles. The road connects with the Chicago, Rock Island & Pacific at Atlantic, Iowa.

About 2,225 sq. yds. of stone block pavement were laid in 1907 in the city of Springfield, Mass., at an average cost of $0.84 per square yard. This cost does not include blocks which were taken from the streets. The pavement was laid in sand. Common labor was paid $2 per 8-hour day, pavers were paid $2.25 to $3.75, and teams with drivers cost $5. Sand cost $0.75 per cubic yard.

The average cost of removing ashes, exclusive of dump maintenance, at Rochester, N. Y., in 1906, was $0.353 per cubic yard. The average weight of a cubic yard of ashes was 921 lbs. The average cost of maintenance of dumps, ashes, scrapings and sweepings was $0.1073 per team load. A team load weighed 3,683 lbs., the average weight of the wagon being 2,100 lbs.

The average cost of cleaning medina block stone streets at Rochester, N. Y., in 1906, was $66.07 per thousand square yards; the streets were cleaned an average of 120 times during the season. The cost of cleaning common medina stone streets during the season of 1906 was $36.72 per thousand square yards. The streets were cleaned an average of 35 times.

As a result of a canvass of 15,000,000 acres of state, municipal and private forests in Germany, it was found that the average net revenue per acre, from good, bad and indifferent land, was $2.40 per year.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Tests of Cast Iron and Reinforced Concrete Culvert Pipe.*

II.

TESTS OF CAST-IRON PIPE.

BY PROF. ARTHUR N. TALBOT.†

Nine cast-iron culvert pipes were tested, four being of 36-in. inside diameter and five being of 48-in. inside diameter. The thickness of the pipe varied, both light-weight and medium-weight being used. One pipe was 6 ft. 8 ins. long, and the others ranged from 8 ft. to 8 ft. 5 ins. over all after the rings for use in the auxiliary tests had been cut from them. Test pieces, 2 ins. wide and about 24 ins. long, were afterward cut from these rings and tested in cross-breaking. The quality of the cast-iron in the pipes was very good. Data on the pipes and rings are given in Table 1.

Testing Machine for Distributed Load.—The machine used for testing the culvert pipe is shown in Fig. 1. The floor of the machine rested on two I-beams. A layer of sand was spread over this floor. On this layer of sand was placed the pipe to be tested. The sides of the box were built up with bridge timbers and held firmly laterally by heavy rods. Sand was put around and over the pipe. The sand was leveled off at the top and the saddle built. Two I-beams, similar to those below the pipe, were placed on the saddle and at the four corners were placed hydraulic jacks with a capacity of 100 tons each. The plungers bore against heavy cast-iron blocks which were connected to blocks under the lower I-beam by means of 16 heavy wrought-iron rods. The jacks were operated by pumps placed on top of the saddle. In this way a fairly even loading of the pipe was obtained.

All the testing under concentrated load was done in the 600,000-lb. machine. A layer of plaster of paris about ¼ in. thick was spread on a strip of building paper lying on the bed of the machine. The ring was put in place so that the bottom element rested in the plaster of paris. A similar layer of plaster was put on the top of the ring and a cast-iron bar 3 ins. wide by 2 ins. thick by 2 ft. long was carefully centered in the plaster over the top element. A second bar of the same dimensions was afterward placed on top of this to give greater stiffness. The head of the machine was then run down and the load applied through a hemispherical bearing block.

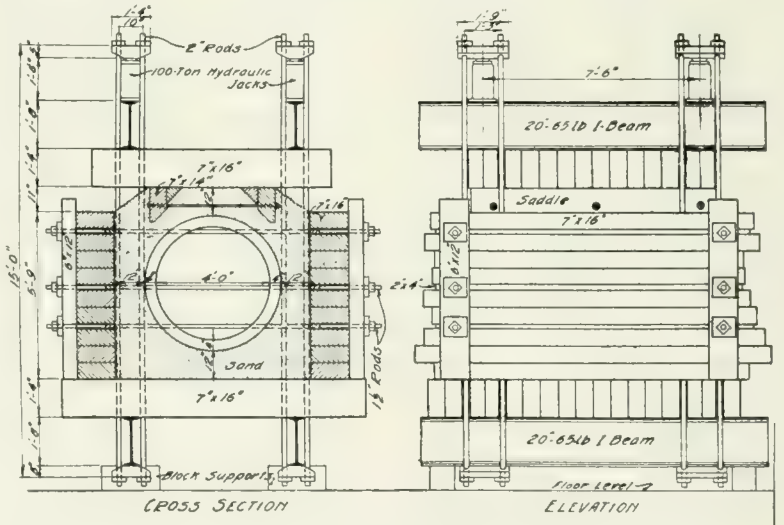


Fig. 1—Hydraulic Jack Testing Machine.

Data of Tests.—Table I gives dimensions of the cast-iron culvert pipes and rings and the name of the railroad company which furnished the pipe. The suffix A denotes the ring cut from the spigot end and the suffix B the ring next to it. In all cases the remainder of the pipe as tested contained the bell of the original pipe, (given in Table III under the heading of Pipes). Table II gives the results of the concentrated-load tests and Table III the results of the distributed-load tests.

In Figs. 2 to 6 are given diagrams showing the amount of the vertical and horizontal deflections of the pipe, at both the spigot end and the bell end, which were produced under the load per lineal foot of pipe or ring indicated by the vertical scale. The full line shows the change in horizontal diameter and the dotted lines the change in vertical diagram. These diagrams will be discussed for the two methods of loading.

Concentrated-Load Tests.—The cast-iron rings which were tested under a concentrated load gave phenomena similar to what would be expected from the anaylsis of the bending moments and resisting moments. As is shown on the diagram in Fig. 2 the amount of deflection is nearly proportional to the applied load. The value of the modulus of elasticity given in Table II calculated from the expression for deflection, for loads and deflections near the breaking load (10,200,000 lb. per sq. in.), is somewhat smaller than the average value of the modulus of elasticity determined from the tests of rectangular specimens cut from the pipe. This is not unexpected for a material as variable in its elastic properties as cast iron and with such a difference in form as the ring and the straight rectangular beam. It seems that the value of the modulus of elasticity determined from the deflections of the rings may best be used in the investigation of the rings and pipe.

At the maximum load sustained, the rings failed at either the top or the bottom, and the rupture extended over the entire length of the pipe in every case. This accords with the theoretical determination already made, it having been found that the bending moment at the top or bottom is about 16/9 that at the extremities of the horizontal diameter. After rupture occurred the machine was in some cases run on down to give greater deflections, but the load then sustained was much less than the breaking load and the rings finally broke again, this time at ends of the horizontal diameter.

It will be seen that the average value of modulus of rupture calculated by equation (7) and given in Table II is 27,000 lbs. per sq. in. This is 25 per cent less than the value of the modulus of rupture determined by loading at the center the rectangular test specimens taken from the rings. The difference which exists in the distribution of the stresses by these two methods of testing and the differences in strength of the materials in the two directions will partly account for this difference. It seems probable that the results given in Table II are more nearly representative of the conditions in the rings and pipe, and in the calculations for the pipes and rings under distributed load the value obtained in the concentrated tests of the corresponding ring has been used.

Phenomena of the Distributed Load Tests.—In the distributed load tests the pipe or ring was bedded in sand, the load was applied through a saddle resting on sand, and the sides of the test box were restrained, as already described. It is not probable that such a method of loading will give a uniform distribution of the load either longitudinally or transversely. It is

---

*Condensed from a paper read before the Western Society of Engineers, April 15, 1908.
†University of Illinois, Urbana, Ill.

evident from a study of results that the distribution of the load is uncertain and that the amount of lateral restraint is also uncertain. While for the purposes of calculation and discussion the distribution of the pressure may be assumed to be uniform over a horizontal section, it is plain that this does not express at all accurately the manner in which the load was distributed. However, a uniform distribution of the load may be used as a basis of comparison in the discussion of the results. A study of the load deflection diagrams given in Figs. 3, 4 and 5 will show the deflection at the spigot end generally began at once and increased nearly proportionately to the amount of the applied load, as is indicated by the approximation to a straight line.

TABLE I. CAST IRON PIPES

Lab. No.	Internal Diameter inches.	Thickness Range inches.	Thickness Average inches.	Length over all inches.	Furnished by
990	48	....	1.25	80	I. C. R. R.
991	48	....	1.25	99	C. M. & St. P. Ry
992	48	....	1.25	99	C. M. & St. P. Ry.
993	48	....	1.50	101	C. R. I. & P Ry.
994	48	....	1.50	96	C. R. I. & P. Ry.
995	36	....	1.00	96	A. T. & S. F. Ry.
996	36	....	1.25	96	A. T. & S. F. Ry.
997	36	....	1.00	96	A. T. & S. F. Ry.
998	36	....	1.25	96	A. T. & S. F. Ry.
CAST IRON RINGS.					
991A	48	....	1.4	24	C. M. & St. P. Ry
991B	48	....	1.25	24	C. M. & St. P. Ry
992A	48	....	...	24	C. M. & St. P. Ry.
992B	48	1.31-1.25	1.28	23	C. M. & St. P. Ry.
993A	48	1.47-1.35	1.43	24	C. R. I. & P. Ry.
993B	48	1.50-1.34	1.42	24	C. R. I. & P. Ry.
994B	48	1.63-1.53	1.58	24	C. R. I. & P. Ry.
994C	48	....	1.6	24	C. R. I. & P. Ry.
995A	36	1.13-0.90	1.02	24	A. T. & S. F. Ry.
995B	36	....	1.1	24	A. T. & S. F. Ry.
996A	36	....	1.44	24	A. T. & S. F. Ry.
996B	36	1.50-1.27	1.42	24	A. T. & S. F. Ry.
997A	36	....	1.00	24	A. T. & S. F. Ry.
997B	36	0.98-0.82	0.91	24	A. T. & S. F. Ry.
998A	36	....	1.25	24	A. T. & S. F. Ry.
998B	36	1.31-1.05	1.19	24	A. T. & S. F. Ry.

TABLE II.—CAST IRON RINGS—CONCENTRATED LOAD.

No.	Breaking load lb. per lin. ft.	Modulus of Rupture.	Modulus of Elasticity.	Remarks.
991A	16,250	32,600	11,000,000	Failed at top.
991B	10,300	26,000	12,700,000	Failed at bottom.
992B	11,720	27,300	9,700,000	Failed at top.
993B	12,850	25,200	7,780,000	Failed at bottom.
994B	17,400	27,600	8,300,000	do
994C	16,500	25,500	8,600,000	Failed at top.
995A	9,650	27,500	10,200,000	Failed at bottom.
995B	13,500	24,000	14,300,000	Failed at top.
996A	17,500	33,300	11,840,000	Failed at bottom.
996B	18,500	26,800	8,800,000	do
997A	6,950	20,600	6,500,000	Failed at top.
997B	6,650	21,800	10,900,000	Failed at bottom.
998A	17,500	33,300	12,400,000	Failed at top.
998B	13,100	23,800	9,700,000	Failed at bottom.

This is in accord with the analysis and with the form of the equation for deflections. At the bell end the deflections lagged behind and generally formed a curved diagram. It is evident that the great stiffness of the bell is the cause of this and that after the barrel of the pipe becomes distorted the effect is transmitted to the bell in varying proportions. At a load varying from 75 percent to 100 percent of the maximum a crack appeared in the top or bottom of the pipe except in No. 996 where it appeared at one side. Usually with an increase of load this extended toward the other end, and finally the pipe broke throughout the full length at or near the maximum load. This generally occurred at the top or bottom of the pipe. The further operation of the testing apparatus gave increased deflections, sometimes without a material reduction, in the load and sometimes at a much lower load, until the pipe broke at some other point in the section.

TABLE III. CAST IRON PIPE AND RINGS—DISTRIBUTED LOAD.

PIPES.

No.	W Load at 1st crack lb. per lin. ft.	W^1 Breaking load lb. per lin ft.	$M^1 = \frac{W^1 d}{16}$	$M_0 = \frac{fbt^2}{6}$	Ratio $\frac{M_0}{M^1}$
990	26,700	37,500	115,000	85,600	0.74
991	22,600	26,400	81,000	102 000	1.26
992	16,300	22,600	69,000	92,300	1.34
993	54,600	54,600	169,000	102,000	0.60
994	47,300	49,300	152,000	134,000	0.88
995	19,300	22,200	52,000	57,800	1.11
996	37,300	37,300	87,000	110,000	1.26
997	25,200	27,300	63,000	38,200	0.61
998	29,300	37,200	86,000	93,400	1.08
RINGS.					
992A	22,150	22,150	68,000	92,500	1.36
993A	29,250	29,250	90,000	104,000	1.16

The following notes of Pipe No. 992 and 994 give the typical phenomena of the tests.

No. 992. Diameter 48 in. Length 8 ft. 3 ins. over all. Light-weight pipe, 6,900 lbs. for 12 ft. net length. Small bell. Average thickness 1.3 in. Loaded 2 in. off center. At a load of 16,300 lbs. per lin. ft. cracks formed at the top and bottom and extended throughout the bell 8 in. into the barrel. At 17,700 lbs. the bottom crack extended from end to end, and at 18,700 lbs. the top crack extended likewise. At 21,600 lbs. both sides cracked from end to end. The load dropped off, and finally rose again, reaching 22,600 lbs. per lin, ft. Test discontinued.

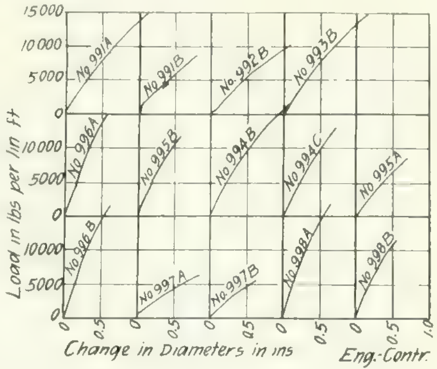


Fig. 2.

No. 994. Diameter 48 ins. Length 8 ft. net. Heavy-weight pipe, 8,900 lbs. for 12 ft. net length. Average thickness 1.58 in. This pipe was cut into two pieces and the end of one was loosely inserted in the bell at the middle of the testing box. The piece containing the bell is denoted the bell section, and the other the spigot section. The center of the loading apparatus was over the bell. The first crack appeared in the bell at the top and extended 2 ft. into the barrel at a load of 47,200 lbs. per lin. ft. At the maximum load of 49,300 lbs. per lin. ft. this crack extended the full length of the bell section. No crack appeared in the spigot. Test discontinued.

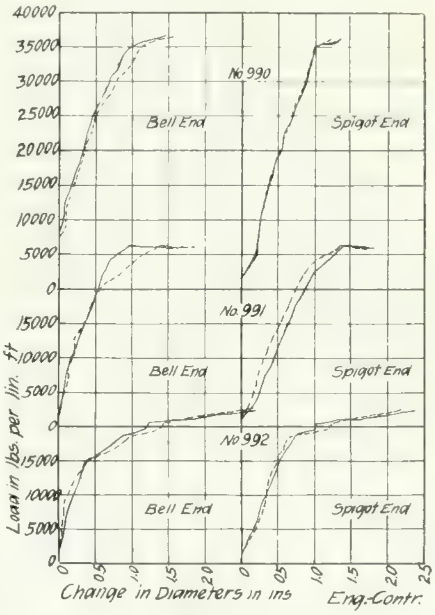


Fig. 3.

The effect of lateral restraint is illustrated in the results of a preliminary test on Pipe No. 990. In this test the hydraulic jack machine was not used, but I-beams were used to transfer the load from the 600,000-lb. testing machine to the saddle, since the box was too large to be placed on the bed of the machine. The distance of the saddle from the testing machine was such that only one-fifth of the load on the machine was applied to the saddle. The load was run up to 16,200 lbs. per lin. ft. on the pipe. At this point an I-beam commenced to buckle and the load was taken off. At this load the change in the vertical diameter was 0.37 in. The load having been taken off, the rods holding the sides of the box were loosened and kept loose and pressure again applied. This time, at a load of 15,500 lbs. per lin. ft., the average change in the vertical diameter was 1.05 in. with no sign of failure. When the load was removed there was a set of 0.65 in. at the spigot end. Four hours later this set was reduced to 0.30 in. The deflections in the two sets is shown in Fig. 6. This pipe was finally tested to destruction in the hydraulic jack machine, the first crack appearing at a load of 26,400 lbs. per lin. ft and the pipe finally carrying 37,500 lbs. per lin. ft. as has already been described.

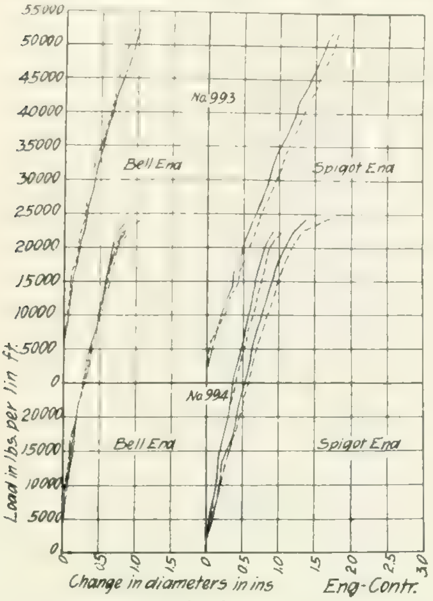


Fig. 4.

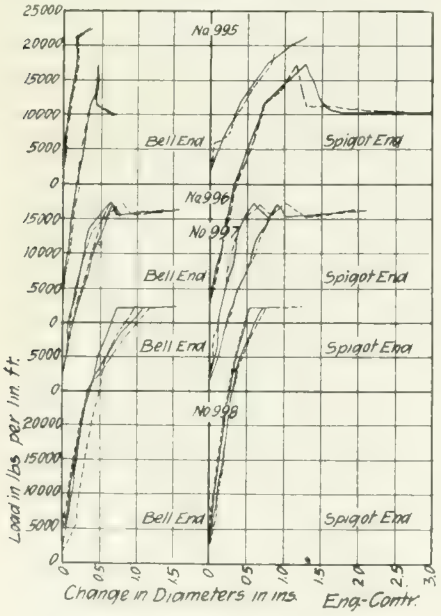


Fig. 5.

Comparison and Discussion. Table III gives data of the distributed-load tests of the cast-iron pipe and rings. The loads are given in pounds per foot of length of ring or pipe. The first crack for which the load is given appeared at the bell end in four pipes and at the spigot end in three. In No. 993 the crack ran from end to end and in No. 994 in which the pipe was cut and the spigot end placed in the bell end at the middle of the test box the first crack was at the bell. The breaking load was the maximum load and generally the indicated load of the testing apparatus fell off at once though in some cases the maximum load held until the deflections had been increased somewhat. M′ is the bending moment based on a uniform distribution of the breaking load over the horizontal section of the pipe and without any allowance for lateral pressure or restraint, as calculated by equation (3). M_0 is the resisting moment of a rectangular section of the pipe, calculated with the value of the modulus of rupture *f* determined from the concentrated load tests of the rings cut from the pipe, except that for No. 990, from which no ring was cut, the average modulus of rupture determined from other pipe was used. In the expression for the resisting moment *b* is the length of pipe or ring and *t* is the average thickness. The last column gives the ratio of the resisting moment to the bending moment thus calculated. If M_0 properly measures the resisting moment and if the load is uniformly distributed over the horizontal section in both the longitudinal and transverse directions this ratio should be unity. If there is lateral pressure of the sand simliarly distributed over the vertical section the value of the ratio should be less than unity and would represent the 1 — q of equation (5). That is to say, if the ratio is 0.75, the lateral pressure would, by this method of reasoning, be 25 per cent of the vertical load. This treatment does not consider the effect of the greater stiffness of the bell nor the effect of the stiffness of the bell upon the stresses in the barrel next to the bell. It is seen that there is a considerable variation in the value of this ratio. The higher values may be due to an uneven distribution of the load either longitudinally or transversely. It is possible that in these cases the pipes were not so well bedded or that the sand was not so well packed about them.

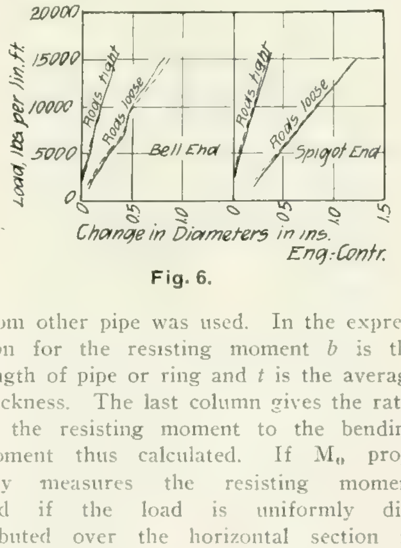


Fig. 6.

Reinforced Concrete Caisson Breakwater at Algoma Harbor, Wis.

In improving the harbor at Algoma, Wis., on Lake Michigan it is planned to construct a breakwater some 1,428 ft. long, the outer 500 ft. of which will be built by sinking reinforced concrete caissons on a pile foundation, filling inside and around them with rip-rap, and capping them with concrete. This description refers to the concrete caisson work only, which is shown by Figs. 1 and 2. The improvement is being carried out under the direction of Major W. V. Judson, Corps of Engineers, U. S. A., Milwaukee, Wis., to whom we are indebted for the information given here. The transverse section of the breakwater and a plan and a longitudinal section of one of the caissons are shown by Fig. 1. The drawings show all the essential dimensions. In constructing the foundations the piles are to be driven to a resistance denoted by a penetration of 2½ ins. from a blow of a 3,500-lb. hammer falling 20 ft., and their tops cut off level at a depth of 11 ft. 4 ins. below datum. Each pile is then to be capped with a cast iron pile cap of the form shown by the sketch in Fig. 2. After being cut off the spaces between piles are to be filled level to within 9 ins. of the pile tops with rip-rap stones weighing 10 lbs. or less.

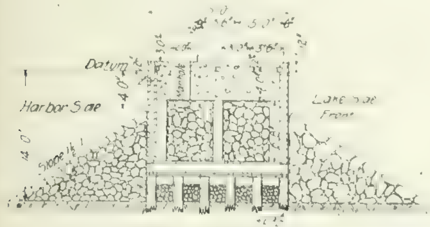
The caissons, as will be seen from the drawings of Fig. 1, are plain rectangular boxes with transverse partitions dividing each into two compartments. For rigidity in handling and towing each caisson is provided with an interior framework carrying a decking of wood as shown. The ends of each caisson carry two guide timbers for use in sinking. These guide timbers are permanent, but the interior frame and decking are temporary and will be removed when once the caissons are sunk finally into place. The permanent filling of the caissons will consist of rip-rap stone to a height of 8 ft. 4 ins., and of a 4-ft. slab of concrete on top of the stones. Before placing the interior rip-rap the posts shown by the cross-section and plan are to be placed. The cover slab is concreted directly on a canvass covering laid on the rip-rap. There is a manhole through the slab into each compartment of the caisson. Figure 2 shows the construction of the reinforced concrete manhole cover. The trapizoidal coping of the breakwater, shown in outline by Fig. 1, will be constructed in 25-ft. lengths, with joints coming over the spaces between caissons. Other structural details can be got from the drawings.

The concrete for the caissons proper will be a 1-2-4 broken stone concrete, that for the covering slab a 1-5-10 mixture and that for the coping a 1-3-5 mixture. All concrete will be mixed wet and tamped in layers. The requirements for concrete finish are as follows:

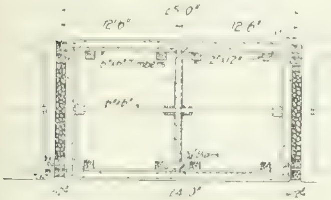
"The approved method for securing smooth faces is to place concrete containing no large broken stone next to the form;

then insert a flat spade between the concrete and the form, pressing it away from the form; then ram it with a face rammer of iron, with its lower face 2 ins. x 6 ins. If it is found that this does not give a perfect face, the operations with the spade and rammer will be repeated. No plastering of faces will be allowed.

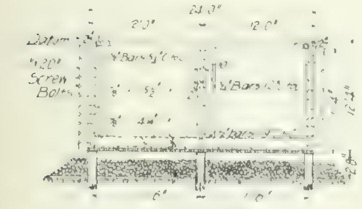
"Concrete faces not in contact with the forms shall be finished in the following manner: The ordinary concrete shall be brought to 3½ ins. below the finished upper surface, and while still unset and plastic, 3 ins. of concrete, containing no large stone, shall be added to bring it up to within ½ in. of the required surface. This shall be tamped and kneaded into the underlying concrete to form a perfect monolith. While this concrete is still unset, ½ in. of mortar, which shall contain 1 part cement and 2 parts sand, shall be added to bring it up to the required surface. This mortar shall be worked down to the required grade by rubbing with a long wooden straightedge. All corners and edges of the finished work shall be neatly rounded."



Section of Breakwater



Plan of Caisson



Section of Caisson

Fig. 1.

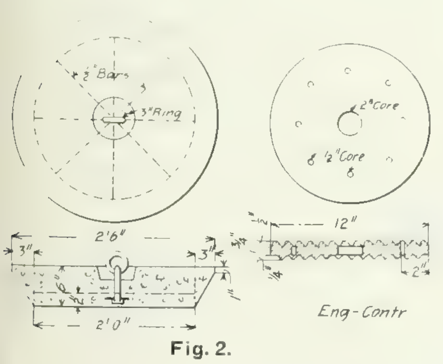


Fig. 2.

The materials required for this caisson breakwater are shown by the following tabulation:

Caissons:	Per Caisson.
Reinforced concrete, cu. yds.	52.21
Reinforcement, lbs.	13,443
Timber, ft. B. M.	2,252
Bolts and nails, lbs.	485
Caisson Filling:	**Per Lin. Ft.**
Concrete (1-5 to mix), cu. yds.	1.01
Timber, ft. B. M.	38.40
Rip-rap stone, tons	3.32
Superstructure:	**Per Lin. Ft.**
Concrete, cu. yd.	0.79
Foundations:	**Per Lin. Ft.**
Piles, lin. ft.	28.8
Rip-rap stone, tons	9.03
Filling Between Caissons.	**Per Caisson.**
Rip-rap stone, tons	5.44
Concrete, cu. yds.	0.53

Cost of a Two-Story Reinforced Concrete Factory Building.*

The building was 100 x 160 ft. with a gore extending 55 ft. along one side. The ceiling heights were, first floor 18 ft., second floor 12 ft. The building was designed in skeleton construction, the windows extending from column to column, insuring a well lighted interior. The curtain walls, which were made 6 ins. thick, were capped with concrete sills. The typical floor panel, 16 x 16 ft., has two intermediate beams. Kahn cup bars were used to reinforce the footings, columns and beams, the floor slab being reinforced with Ideal wire reinforcement.

The mixing and hoisting equipment consisted of a No. 1 Smith batch mixer, capacity 10 cu. yds. per hour; one boiler, which provided sufficient power for both hoisting and running engines, and a Ransome bucket in which the concrete was elevated to upper floor and roof. A hopper with a cut off into which the bucket dumped automatically prevented any delay while concrete was being poured.

The column and beam centering consited of 2 in. Norway pine, dressed four sides. Considerable labor and expense was done away with by using iron clamps for column and beam boxes. The beam centering was supported at intervals of two feet by 4 x 4 in. cedar posts, crossed braced, under which maple wedges were placed. The floor centering was built of 1 in. Norway pine, dressed one side, laid on 2 x 4's, 18 in. centers, supported by strips on sides of beam boxes. To keep the carpenters continuously employed the column and beam boxes were prepared while the concrete footings were poured; these were afterwards erected and framed.

A mixture of 1 part cement, 2 parts clean sharp sand, and 4 parts gravel to pass a 1-in. ring was used for concrete. The 1-in. finish was laid with floor and consisted of 1 part cement to 2 parts sand.

Complete cost data were kept during construction from which the following summary of totals and unit costs were compiled based on a volume of 847 cu. yd. of concrete:

MATERIALS	Total	Per cu. yd.
Cement at $2.05 per bbl.	$ 3,314	$ 3.91
Sand and gravel at $1.25 per cu. yd.	1,054	1.24
Reinforcement at $55 per ton	2,314	2.75
FORM LUMBER		
4 x 4 in. cedar at $[illegible].25 per M., 2 x 4 in. N. pine at $27 per M., 1-in. flooring at $28 per M.	4,944	5.84
Nails, etc.	107	0.13
Total materials	$11,733	$13.88
LABOR		
Building Runs, Hoisting and Mixing		
Engineer, 378 hrs. at 25 cts	$ 94.50	$0.111
Laborers, 3,826 hrs. at 17½ cts	669.55	0.790
Carpenters, 308½ hrs. at 35 cts	107.98	0.127
Total	$872.03	$1.028
PLACING AND TAMPING		
Laborers, 3,211½ hrs. at 17½ cts	$ 562.00	$0.663
PLACING REINFORCEMENT		
Laborers, 1,263 hrs. at 17½ cts	$ 221.00	$0.260
BUILDING AND ERECTING FORMS		
Carpenters, 4,700 hrs. at 35 cts	$1,645.00	$1.942
Carpenters, 1,212 hrs. at 30 cts	364.50	0.430
Total	$2,009.50	$2.372
STRIPPING CENTERING, CLEANING UP		
Carpenters, 420 hrs. at 30 cts	$126.00	$0.148
Laborers, 1,451 hrs. at 17½ cts	253.93	0.299
Total	$379.93	$0.447
SUPERINTENDENCE		
Foreman, 44 days at $6	$264.00	$.311
Superintendent, 2½ months at $100	250.00	0.295
Engineering inspecting, inc. trav. exp.	200.00	0.236
Total	$714.00	$0.842
Tools and depreciation	$338.00	$0.386
Total labor	$5,096.46	$5.998
Total materials and labor	$16,829.46	$19.878

In reference to these costs the engineer writes: "By an arrangement with the owners, we employed as many of their factory hands as possible at 17½ cts. an hour. Their former building was destroyed by fire and the firm desired to keep as many of their old hands employed as possible. The carpenters were paid 35 cts. an hour with the exception of a few at 30 cts."

---

*Rearranged from an article by D. E. Raymond, The Concrete Engineering & Construction Co., Ltd., Toronto, Ont., in "Applied Science" for December 1907 with additional matter, furnished us by the author.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Cost of Diamond Drilling in Mexico.*

Mapimi is about 15 miles southwest of Bermejillo, with which it is connected by a 30-in. gage road, owned and operated by the company. It is at the northwestern extremity of the Sierra de la Bufa de Mapimi.

The company's general offices, power plant, and reduction works are at Mapimi, but its mines are at Ojuela, about 6 miles away in the hills. The formation encountered is one which makes diamond drilling an economic necessity. The ore, a silver-lead, occurring as sulphide, oxide and carbonate, is deposited irregularly in pockets of varying dimensions, usually connected by pipes or stringers through the country rock of limestone. The mine is opened by levels from the shaft, and on each level drifts are run at right angles, about 384 ft. apart. The territory covered by the mine is thus divided by the levels and drifts into cubes. These cubes are carefully probed by diamond-drill holes, run from the drifts, in all directions, to determine the location of the pockets, their size and frequency, and the best points from which to reach them. By this method it is impossible to miss any body of ore of appreciable extent, and at the same time, if ore is not discovered, the expense of drifting is avoided.

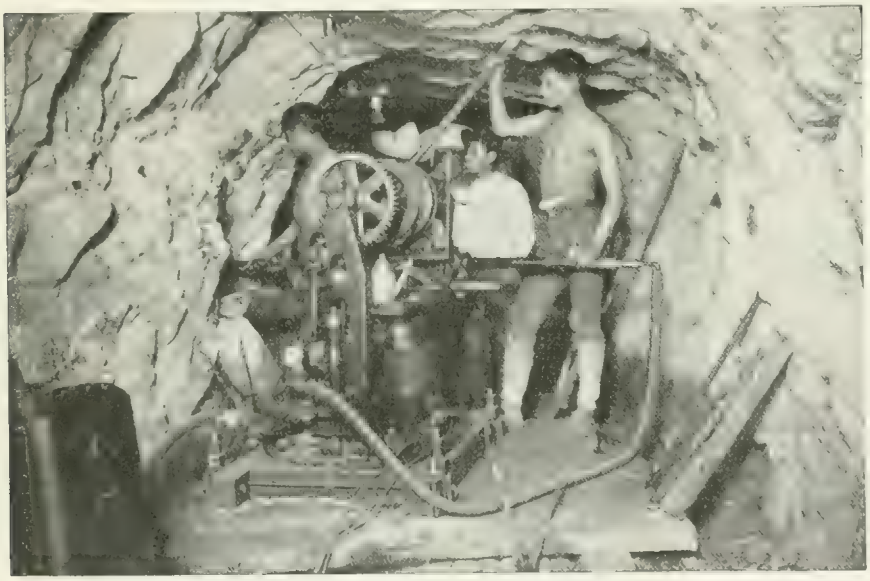


Fig. 1—View Showing Drill in Operation

The company at present employs 17 diamond drills, and performs about 12,000 ft. of core drilling per month. The drill-holes are run at right angles to the drifts, about 16.4 ft. apart, to an average depth of about 199 ft. Horizontal holes predominate, but there is also considerable angle work.

Four of the machines are of the Sullivan "R" type, which have a capacity of 300 ft. in depth and remove a 15/16-in. core. These drills are fitted with improved screw feed with friction escapement, and are operated by electric motors on a 250-volt direct current, which is stepped down from the 6,600 volt alternating current transmitted from the power plant at Mapimi. The remaining drills are of an early Swedish type. They are run by small electric motors, but the diamond bit is advanced by hand.

The average cost of drilling for the year 1906 for all the drills was about 50 cts. per ft. Two Mexicans are employed on each drill, a runner at $1.58 and a helper at 99 cts. The average about 16.4 ft. per 10-hour shift with the Swedish drills and 23 ft. with the Sullivan "R" machines. The cost of labor only, for the Swedish drills is thus 15 cts. per ft, and 11 cts. for the Sullivan drills.

Owing to the soft, even character of the rock, it is possible to use small carbon, weighing about one karat, of a grade costing $40 gold per karat. The table shows the average cost of the company's drilling work for the first five months of 1907. All values are figured in U. S. currency. Fig. 1 shows one of the Sullivan drills in operation.

Month.	Labor cost, including salaries of foremen, setter, etc. Per ft.	Diamonds, cost per ft. Diamonds at $40 per karat	Total cost, including power, etc. Per ft.	Average drilled per month, per machine, ft. ....
Jan. ...	$.24	$.027	$.42	951
Feb. ...	.22	.072	.43	872
Mar. ...	.21	.023	.41	820
Apr. ...	.22	.067	.40	938
May ...	.28	.045	.46	886
Average for 5 months..	$.24	$.047	$.42	893.4

Two slides of comparatively novel character recently developed in the upper level of the Culebra Cut of the Isthmian Canal. One of the slides, states the "Canal Record," is located on the west bank of the cut at the village of New Culebra, which is built entirely upon an old French dump. This material, which had caused some little trouble previously, began three or four weeks ago to break away and slide in to the cut, until at the present time the most distant point of the slide from the edge of the cut is about 170 ft., and only about 35 ft. from the edge of the street running through New Culebra. The total amount of material involved in the slide was about 40,000 cu. yds. This slide can not extend more than 75 or 100 ft. further from the cut, as this distance marks the upper limit of the old lump which causes the slide. The other slide is located directly opposite the village of Las Cascadas, and extends back from the edge of the cut for a distance of about 260 ft. The amount of material involved was about 100,000 cu. yds. The two slides are unusual in that they occurred during the dry season, and that the bulk of the material composing them is quite dry, especially in the case of the slide opposite Las Cascadas. The material at the bottom of the slide at the village of New Culebra is moist, but not at all wet, and in both cases the mass in motion is a superficial top covering of earth, 20 to 30 ft. thick, deficient in cohesion, and comparatively dry, moving upon a gently sloping bed of much harder material which is smooth and soapy to the touch.

The U. S. Navy Department is to hold an examination at the Federal Building, Chicago, Ill., on May 8, for the purpose of establishing an eligible register of sub-inspectors of building construction works. The pay of first-grade positions is $4.00 to $5.04 per day, and the pay of second-grade positions is $2.48 to $3.52 per day. The examination is open to all who can give satisfactory evidence of experience in the kind of work for which they seek employment, and are citizens of the United States. Persons desiring to take the examination should address the Commandant Naval Training Station, Great Lakes, North Chicago, Ill., on or before May 6.

---

*Condensed from an article by J. F. Bennett, El Paso, Tex., in "Mine and Quarry."

LETTERS TO THE EDITORS.

The Cost of Spreading Earth in Rolled Embankments.

Sirs: The writer has been much interested in the recent articles in ENGINEERING-CONTRACTING advocating the cost-analysis method for use in preparing estimates on the probable cost of new work. While this method has much to commend it, yet it may prove disastrous in the hands of inexperienced users, who have only a partial knowledge of the conditions prevailing at the time the particular cost data were collected.

As an illustration of the incorrect conclusion which may be drawn, even by an expert in this method of analysis, the results given for estimated cost of rolled embankment in the issue of Feb. 12, 1908, are instructive.

Judged by the present writer's own notes, collected on very similar work, several of the estimated costs of the primary operations as given on pp 101 and 102 of the above-mentioned article are open to suspicion; but particularly the cost of spreading, which latter is given as 1.8 cts. per cu. yd.

This cost of spreading apparently is based upon the cost of similar work at the Tabeaud dam. In the latter case, although a steam shovel is listed with the contractor's equipment, apparently it was not used, as Mr. Bassell, in his book (Earth Dams), states that the material was loaded by buck scrapers through traps into wagons. Now the spreading of earth as delivered upon an embankment by wagons is a much simpler matter than when precisely the same material is delivered from cars; as may be shown by the following comparison:

In a large earthen embankment, being built of clayey materials. rolled in 6-in layers, two methods of working have been in use simultaneously on adjoining portions of the work. In one case elevating graders loaded 1½ cu. yd. Aurora dump wagons, with an average load of 1.1 cu yds., bank measure, as determined from 100,000 loads. Each wagon load would make 60 sq. ft. of 6-in. layer in embankment. Hence the loads were deposited in rows 7 ft. apart, and piles about 9 ft. distant in each row. As the material, from its method of excavation, did not contain many large lumps, a 6-horse road leveler had no difficulty in leveling the same, at a cost very close to the 1.8 cts. per cu. yd. as noted on page 102 of the issue of ENGINEERING-CONTRACTING hereinbefore mentioned.

In the second case 75-ton steam shovels, working in similar material in a cut 18 ft. deep, loaded 10-car trains of 4-cu. yd. side dump cars, drawn by 18-ton dinkey locomotives. This appears to be the method of working contemplated at the Ashokan dikes. In car work the track has to be shifted every train load; or else the earth has to be moved bodily away from the track a considerable distance, and in addition the track has to be shifted every second or third layer to avoid soft spots in the embankment.

The average car load, as determined from about 100,000 loads, has been 3.1 cu. yds. measured in embankment; hence each load makes about 168 sq. ft. of 6-in. layer, and, as cars are coupled 13 ft. center to center, each train load should spread 13 ft. laterally. When cars are dumped simultaneously, so much earth falls back onto the rail that it is difficult to clear the train. Better results have been obtained by dumping every alternate car, then pulling ahead a train length, and dumping the balance. This makes earth piles 26 ft. apart on centers, and calls for a layer to be 6.5 ft. wide

The narrow gage "Western Embankment Spreader" will spread about 7 ft. from the rail. This appliance was tried, but the locomotives were not powerful enough to pull it successfully. Material excavated by the steam shovels contained so many large lumps that in attempting to spread the piles with a 6-horse road leveler the latter was thrown about like a small boat in a high sea. Preliminary spreading had to be done with buck scrapers, and the road leveler used only to complete the operation.

The contractor had a choice of pulling the earth away from the track and shifting the latter every third layer, or of throwing the track away from the earth 6.5 ft. for each train load. In either case the cost of shifting track should be included when comparing the cost of spreading with the similar cost where wagons are used. When the earth is pulled away from the track it is hauled by buck scrapers for about 50 ft. on either side; and if three layers are placed before shifting track, and the latter is then moved 10 ft. laterally, we have 180 lin. ft. of track shifted 10 ft. for every 1,000 cu. yds. of embankment. This track, however, requires constant attention to keep it up to grade, and is also very hard to shift as it gets so well bonded into the embankment.

On the other hand, if the track is shifted 6.5 ft. for every train load, we have 8,300 ft. of track shifted 6.5 ft. for every 1,000 cu. yds. of embankment. The embankment is very wide, and is on a 3° curve; therefore the cost of shifting is considerable.

Heretofore the contractor has elected to move his earth away from the track, and the cost per cubic yard for dumping, spreading, and shifting track has been about seven times the cost of spreading materials dumped from wagons.

In referring to the article in ENGINEERING-CONTRACTING before mentioned, it is fair to assume that the wages of the dump boss and of a portion of the 14 dumpmen and trackmen should be added to the 1.8 cts. given for cost of spreading, before comparing same with the cost, 12 cts., for car work noted by the present writer; but even after making all due allowances, the statement as published certainly underestimates the expense of dumping and spreading materials delivered from cars.

W. M. Patch,

Orman, S. D. Mem. Am. Soc. C. E.

[It is true, as our correspondent states, that cost analysis, in the hands of inexperienced users, may lead to erroneous conclusions. It is also true that if one is to use only cost data of his own collecting on work done by or under him, he may likewise arrive at erroneous conclusions, and estimates made from such data may be of questionable value.

The estimate referred to, being that of the Ashokan dam, was not based upon the cost of spreading as done at the Tabeaud dam, but was based upon all available published data on spreading earth on dikes, and upon the experience of the estimators and the knowledge of the conditions surrounding the work and of the materials to be found at Ashokan. This led to the estimate of 1.8 cts. as the probable cost.

To corroborate this estimate we have the cost of spreading earth, as done by the Reclamation Service at the Upper Deer Flat embankment, on the Payette-Boise project. Here an embankment of 1,000,000 cu. yds. is being built with steam shovels and with cars and dinkeys, under conditions similar to those that Mr. Patch gives for his 12-ct. cost. On the Upper Deer Flat embankment the cost for spreading during Nov., 1907, was 1.4 cts. per cu. yd., while for the entire job up to December, 1907, the cost of spreading was 1.9 cts. per cu. yd.

The method used was entirely different from that described by Mr. Patch, however. After the cars are dumped, heavy Percheron horses pull the track away from the dumped earth, and road machines do the spreading, two road machines spreading about 300 cu. yds. per hour. The track lies flat upon the ground, the ties, being 6 x 8, and the track stands the rough usage very well.

It would seem from this that the method described by Mr. Patch, which cost 12 cts. per cu. yd., or 6 to 7 times as much as at Upper Deer Flat, is clearly the wrong method to use. If the earth excavated by the shovels came from the cars in large clods or lumps, a few cents a cubic yard would have broken up these clods, if done in no better way by a man with a sledge hammer or maul. It is certainly evident that a cost of 12 cts. per cu. yd. for spreading is so high that the method used must be wrong.

The cost of spreading earth at Ashokan if done in the same manner as at Upper Deer Flat—and there are no reasons why it cannot be so done—will not exceed in cost the estimate given in our issue of Feb. 12, 1908. The earth at Ashokan will not come out in lumps, although there may be an excessive amount of stone

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Some Economic Advantages of Large Size Drain Tile.*

E. M. OKEY.†

Relative to the length of drain tile, there is little to be said except a rehash of what has already been said on the subject. The length most commonly in use is 12 ins., at least for diameters of 12 ins. and less, and any additional length would not be of very great advantage. Where the drains in question are trunk lines of large diameter and run for considerable distances, tiles longer than 12 ins. may be used with best results. The reason for this is readily apparent. Much of the water carried by the trunk lines is received from the lateral drains emptying into them. Trunk lines are usually put in more to carry off the water collected by the laterals than for actual drainage, and it is not necessary that there be many joints to receive additional water. And if there were water to be removed along the line of the main there would be sufficient openings to take care of it, owing to the increased length, even though the tile were 2 ft. long, and to the increase in actual area of opening at each joint, due to the increase in circumference of the large tile over that of the small tile in the laterals. So, for long drains, tiles longer than 12 ins. are to be recommended, as they are somewhat more easily laid and are not so likely to alter their position in a long drain after being laid. Otherwise, the long tiles have but little superiority over the short ones.

Taking up the discussion of the sizes of drain tile and, more specifically, the advantages of large size drain tile, I seem to be entering a field of unknown area and possibilities. It took but a very superficial study of the question to convince me that I knew very little about it, and after an exhaustive search through books and papers on tile and tile drainage, I am of the opinion that no one else knows much more, or if they do, they have not given the public the benefit of their knowledge.

At one time, a tile which had an inside diameter of 1 in. was considered sufficient, but to-day a tile is not considered of adequate bore unless it be at least 3 ins. in diameter. The consensus of opinion among drainage engineers seems to be leaning toward larger sizes, and this is so far affecting the situation that a few of the tile companies will not give quotations on a size less than 4 ins. The advantages of the larger sizes may be readily seen when we consider that in many soils and strata, there is more or less water coming all the time from underground springs which would fill the smaller tile nearly or quite to their capacity, but which is nothing to be compared with the water around them after a heavy rain, or during spring thaws. The water runs off so slowly that it has time to thoroughly chill the ground. The result is wet ground for a considerable period of time, and delayed agricultural work, while if larger sizes are used, the surplus water is carried off easily and quickly before it has time to do any damage by puddling or chilling the ground. The size depends largely, of course, upon the area to be drained and whether the line is a lateral or a trunk line. A quick relief from surplus water is very necessary to some soils, for if allowed to become saturated, they become hard and cracked when heated, a condition to be avoided if possible.

Considering that a tile of 3 ins. internal diameter is the smallest size that should be used under any circumstances, and using it as a basis of comparisons, let me present a few apparent advantages of the larger sizes.

The cross-sectional area of a 3-in. tile is 7+ sq. ins.; that of a 4-in., about 12½ sq. ins.; that of a 5-in., 19 sq. ins.; and that of a 6-in., 28 and a fraction sq. ins., or just four times that of a 3-in., though the diameter is only twice as great. In fact this is true of all tile; double the diameter and the cross-sectional area is four times as great. Assume that enough dirt has entered through the joints and at the end of a 3-in. tile to fill it, and thus completely destroy its efficiency. As just mentioned, the 3-in. tile has a sectional area of a trifle over 7 sq. ins., and the 4-in. an area of practically 12½ sq. ins., or about 80 per cent more. If this same amount of dirt entered a 4-in. tile it would fill it only a little over half full, or to speak exactly, 58 per cent full. There enters here the possibility that more dirt might enter the tile of larger size owing to increased circumference and area. But with due precautions taken, there is not much chance of this. However, if we allow that 25 per cent more dirt gets in, which is a very high estimate, unless it be at points on a curve where the outside of the line has the joints opened a trifle, the 4-in. tile would still be only a little over 70 per cent choked, leaving an available waterway of 30 per cent of its area. Not much to be sure, but still a great deal better than a 3-in. tile entirely choked up. But assuming that enough water is to be provided for to fill a 3-in. tile, this same amount in a 4-in. tile would have a slightly increased velocity of flow, and have thus a greater tendency to wash the dirt out. Perhaps not nearly all of it, but certainly much more than would be washed from the 3-in.

Allow me to go further and compare the 3-in. tile to that whose diameter is 5 ins. The 5-in. tile has a sectional area of 19 sq. ins., or 27 times that of a 3-in. Therefore, the dirt that would fill a 3-in. tile full, would fill a 5-in. only 37 per cent, or a little over one-third, full. We might assume further that an additional 25 per cent of dirt enters. The 5-in. tile is still 4 per cent less than half full and has an available waterway of 1½ times that of a clean 3-in. tile.

Comparisons may be made still further by comparing the 3-in. tile with those of still larger diameter than those mentioned, the 4-in. with the 5-in. and 6-in., and so on, but we are concerned chiefly with the smaller sizes in this part of the discussion, namely, the 3-in., 4-in. and 5-in. tiles.

Then the larger sizes have an economic value relative to cost. According to a table compiled from formulas recommended by Mr. C. G. Elliott, drainage engineer to the United States Agricultural Department, a 3-in. tile laid at a 0.25 per cent grade, or a fall of ⅜ in. per rod, is adequite to drain 5 acres. But a 4-in. tile laid at the same grade will drain 10 acres. In other words, it has twice the capacity of the 3-in. tile. So if we found that there was a little too much water for the 3-in. tile to carry away, we could be sure that a 4-in. tile would have no trouble in taking care of all of it. The computations for making the above mentioned tables are based on the assumption that the tile removes ¼ in. depth of water per 24 hours.

Assuming that a tile is effective one rod each side for each foot of depth in the ground, and that the tile is in 4 ft., it will drain a strip 8 rods wide. In the case of the 3-in. tile, which drains 5 acres, the line will be 100 rods, or 1,650 ft., long, and the line of 4-in. which drains 10 acres will be twice as long, or 3,300 ft. So if we wish to drain 10 acres with 3-in. tile, it will be necessary to put in two rows of them 8 rods apart, running 1,650 ft., the length to which we are limited. But when we come to the end of this distance, it is necessary to either increase the size of the tile or to put in intercepting drains. If the former, it will not be possible to run them half their available distance until it will be again necessary to increase the size. If the latter, there will be the increased cost of the intercepting drain. Furthermore, if the smallest size is put in at the upper end of a system, it will never be possible to make any extensions in that territory without going to the greatly added expense of taking up the small tile and replacing them with larger ones, very likely causing a revision of the entire system, which is decidedly more expensive than putting in the larger size in the first place, even at a greater cost. About how great this increase is, may be drawn from the following:

---

*Abstracted from a paper in "Iowa Engineer," Ames, Ia., for January, 1908.

†Ames, Iowa.

Based on actual cost, and compared as to cost of unit area, using the area of a 3-in. tile as the unit of comparison, there is an advantage in favor of the larger tile. The 4-in. tile costs only 20 per cent more than the 3-in., but has a sectional area 80 per cent greater; 5-in. costs 60 per cent more than the 3-in. and has a sectional area greater by 2.7 times that of 3-in. Also the 5-in. costs 33⅓ per cent more than the 4-in., but has a sectional area 60 per cent greater than the 4-in. Superficially, a case of getting more for your money by buying the larger tile. But when it is considered that there is less likelihood of the larger tile choking up; that they will remove the water more quickly; that they will drain a larger area per given length of tile; and that there is practically no difference in the cost of laying the smaller sizes from the 6-in. down, the economy of the larger tile is easily apparent. There are, of course, places where it would be folly to place tile of small diameter, such as bogs, swamps and marshes, or where there is considerable surface water likely to find entrance. In such places there is continually so large a supply of water to be removed that it would take several lines of the small size laid close together to provide an ample waterway. Considering the added cost of the extra ditching in such places, as well as the added cost of the extra tile, the economy of the large tile is at once evident. Quick relief from surplus water is what is wanted in every case and such relief will be obtained only by using the tile of large diameter. So in view of all that I have said, let me urge that no tile be put in which has a diameter less than 4 ins., or, if there is the least doubt about that size being adequate, put in a 5-in. I have confidence in this statement not only because of my own belief, but because some of the prominent drainage engineers are advocating this and are requiring the use of sizes larger than 3-in., and by the fact that fewer 3-in. tile are being used every year. So much for the advantages of large tile over small ones.

Turning our consideration now to another phase of the question, I would like to present a few points wherein a very large tile has the advantage over an open ditch. I will admit that there are places where an open ditch is the only practical kind of a drain and that the drainage of some sections of country would be out of the question if a drainage ditch could not be used. But with the manufacture of the very large size tile, a diameter of 38 ins. being about the maximum, we are able to provide a means of discharge for an enormous amount of water. So when we find a district too large for the largest size, nothing short of a small river will care for the surplus water.

Referring again to the table giving the areas drained by the different size tile, I find that a 24-in. tile laid at a 2 per cent grade will drain about 2,600 acres. The smallest ditch that will care for the drainage of such an area is 4 ft. deep, has a grade of 0.6 per cent, an average width of water of 6 ft., and is about 12 ft. wide on top. This is based on the ditch running three-fourths full, or having in it 3 ft. of water in depth. Take a tile 36 ins. in diameter. This has an area a little over twice as great as the 24-inch and a discharge about 2.25 times as great, or will be effective in draining 6,000 acres providing it is laid at the same grade. The smallest ditch that will drain this area is 4 ft. deep and 16 ft. wide and has an average width of water of 8 ft., the grade being the same as in the first. The first cost of these ditches is low compared with the tile, but that is not all to be considered. A ditch 16 ft. wide on top takes up a strip about 4 rods wide that is not available for farm land, which means an acre for every 40 rods in length. Of course this is not to be counted if the ditch is necessary to make the land tillable along it, but if it be only an outlet, it is decidedly expensive. The open ditch requires constant care to keep it free from weeds and dirt caving from the sides which greatly reduce its efficiency. There is also the added danger of an overflow which may cause an inestimable amount of damage.

With the use of the tile all of these disadvantages are eliminated. When the tile are once in the ground, all expense ceases, for there is no maintenance required. They do not deprive the farmer of the use of several acres of valuable farm land, for the land may be cultivated immediately above the tile, and there is never danger of overflow. So I believe that the greater weight of the argument is in favor of the tile, even though they may be more expensive when they are first put in.

In conclusion, I would like to mention the fact that some of the points that go to decide which is really the best size of drain tile to use, are, as yet, unsolved problems of engineering. Many items involved in working out some of our conclusions are merely reasonable assumptions and not established facts. I will mention those which appeal to me as bearing most strongy on this question.

It is not known definitely how far a tile is effective on either side, nor how deep it should be placed in the ground. Neither is it possible to say definitely how much water in inches of depth we can reasonably expect a tile to remove during 24 hours, or whether or not the tile becomes more efficient after an extended period of time as claimed by some. So far as I am aware, there are practically no data upon any of these points.

In order that some light may be thrown on these things, the Engineering Experiment Station of the Iowa State College is carrying on a series of experiments on two drainage systems, from which we expect to determine, by a system of pipes for determining the fluctuations in the elevation of the ground water, and wiers to measure the actual quantity of run off, whether or not the assumptions mentioned above are as reasonable as they seem, and if they are not, just where the fallacy lies. This experiment has not been in progress for any extended period of time, and we have no definite results to offer as yet. However, it is hoped that by this time next year, enough data will have been collected to justify a report on the subject. I am sure that the experiment will be of great interest to every one concerned in drainage work, either directly or indirectly, and that the report of the results will be awaited with considerable anticipation.

Engineering courses, laboratory practice and research work of interest to practicing engineers, contractors, and graduates of technical schools will be given in the coming summer session of the College of Engineering of the University of Wisconsin, beginning June 22nd and continuing six weeks. The main purpose of the summer session of the College of Engineering is to place at the disposal of practicing engineers, teachers in technical schools, and other advanced students of engineering, all the facilities of the college. Emphasis is laid upon work of a distinctly advanced character, so that engineers may with confidence turn to the college, in the summer time, and work out in its laboratories, with every assistance from its instructional force, problems affecting their professional success during the remainder of the year. Bulletins describing the course in detail may be obtained from Prof. F. E. Turneaure, Dean, College of Engineering, Madison, Wis.

Reports regarding coal mine accidents of 1907 received by the Technologic Branch of the U. S. Geological Survey, show an increase of about 50 per cent in the number of men killed as compared with 1906. From the information already received it seems probable that an increase of 25 per cent in the number of fatal accidents will be shown for the year 1907 over the figures for 1906, without taking into consideration the disaster of last December, in which 694 men were killed. Counting the big disasters, the deaths will be more than 3,000, which will be a 50 per cent increase over the year 1906. The figures regarding injuries, as far as received, show an increase of more than 57 per cent in the number of men injured.

The German empire has nearly 35,000,000 acres of forest, of which 31.9 percent belongs to the state, 1.8 per cent to the crown, 16.1 per cent to communities, 46.5 per cent to private persons, 1.6 per cent to corporations, and the remainder to institutions and associations.

Methods and Costs; Some Old; Some New.

Adobe Road Construction in California.

One very difficult problem in road construction in California is the proper handling of adobe soil for roadbeds. A considerable mileage of the country roads traverse this soil, and during the winter months are practically impassable. In his annual report N. Ellery, state highway commissioner, states that a simple remedy is to saturate the adobe, when slightly plastic, with sand or fine gravel, that it may have body and capacity to hold weight. Extra care should be taken in graveling or macadamizing on an adobe soil, for if only a narrow strip of gravel or macadam is laid down, vehicles will pick up the wet adobe on either side, and beginning at the shoulders of the road will gradually force the stone or gravel into the mud, thus creating a rough road of adobe slush and uneven rock. A 16-ft. width for gravel or macadam improvement on adobe soils is recommended.

Cost of Repairs of Steel and of Wood Cars.—The following data showing the relative cost of repairs of steel and wood cars on the Pittsburg & Lake Erie R. R., about 58 per cent of whose freight cars are steel, are given by Mr. G. E. Carson, master car builder:

100 wood cars requiring heavy repairs:

	Total.	Av. Per Car.
Cost of material	$2,521	$25.21
Labor and supervision	1,631	16.31
Total	$4,152	$41.52

100 steel cars requiring heavy repairs:

	Total.	Av. Per Car.
Cost of material	$3,424	$34.24
Labor and superviion	2,292	22.92
Total	$5,716	$57.16

A very accurate record was kept of the average number of times the different classes of cars were called into the shop for light, medium, and heavy repairs, covering a period of one year, as follows:

Average number of times one wood car was in shop during one year..7 times
Average cost of repairs each time in shop........................$16.23
Average number of times one wood coke car was in shop during one year ....6 times
Average cost of repairs each time in shop........................$10.74
Average number of times one steel car was in shop during one year ....1⅓ times
Average cost of repairs each time in shop ....$ 6.74

The above figures represent the cost of material and labor less scrap credits, and is the average cost of the total repairs to 11,338 steel cars and 20,732 wood cars.

Reinforced Concrete Slab Over Refilled Trenches.—The city engineer of Easton, Pa., Mr. John McNeal, Jr., has for some time required that a reinforced concrete slab be used over refilled trenches in paved streets of that city. The construction was recently described by Mr. McNeal in the Transactions of the American Society of Civil Engineers, Vol. 60, page 217. The specifications require that after the trench has been properly backfilled, the old concrete shall be removed at least 1 ft. on each side of the trench and expanded metal placed over the entire opening. A thickness of 6 ins. of 1-3-5 Portland cement concrete is placed over and around the expanded metal so that the metal is imbedded 1½ ins. above the base. After the concrete is thoroughly rammed to an even surface the paving material is replaced to conform with the adjoining surface. For a trench not more than 20 ins. wide, expanded metal is used, of 3-in. mesh and No. 10 gage steel, having a cross-sectional area of not less than 0.185 sq. in. per foot of width. The cost of making repairs over a trench 20 ins. wide is stated to be as follows: Removal of old concrete for a width of 12 ins. in each side of opened trench, about ½ ct. per square foot; expanded metal of 3-in. mesh and No. 10 gage steel, 4½ cts. per square foot; concrete, 10 cts. per square foot.

Tree Planting by the Massachusetts Highway Commission.—In 1904 the Massachusetts Highway Commission began the planting of trees along state roads. The total number of trees planted that year was 3,907, the varieties being as follows: 1,737 maples, sugar, Norway and white; 538 oak, red, scarlet, white and pin; 1,000 elm, 207 poplar and some white pine and locust. The total cost of these trees in their final location, including transplanting in a temporary nursery, care, manure, superintendence and labor, was $4,348.59, or an average of $1.14 per tree. During the fall of 1904 there was an unusually severe drought, which had a marked effect on the trees planted at that time. The total loss of trees was 15 per cent, this loss being traceable in a large degree to the dry weather. As a result greater care was taken in 1905 in preparing the ground for the reception of the trees. In 1905 the commission began placing in the state nursery all trees received from the nurserymen, so that the trees might get added development of root fibers. This made necessary two transplantings before the tree reached its final location. The cost of trees, transplanting, preparation of ground and final planting, in 1905, was $1.01 per tree. The original cost of each tree was higher in 1904, but more care was given to the preparation of the ground. The work for the year was as follows: Trees replaced, 726; new plantings, 3,239; vines planted, 300. In 1906 the systematic planting of trees along the state highways was continued, 2,511 new trees being planted that year. In addition 1,011 trees were replaced. The cost of planting the new trees in 1906, including the cost of tree and every expense connected therewith was $1.10 each. The cost ot the maintenance of trees planted previous to 1906 was 16 cts. per tree, and including the cost of replaced trees 20 cts.

Road Construction in Gumbo Soil.—In 1906 Mr. George W. Cooley, State Engineer of Minnesota, constructed an experimental road in the gumbo soil of the Red River Valley. A section of road, running north from Crookston, was selected for the experiment. From Station 0 to Station 22 the road had been kept in good condition, so the principal work done on that portion was on the ditches to provide for perfect drainage. From Station 22 north all sod was removed from the side of the road, and ditches and roadbed well rounded, after which gravel, obtained from a pit on about a 1½ mile haul, was placed on the road at the rate of 14 cu. yds. per station of 100 ft. or 739 cu. yds. per mile, and for a width of 14 ft. The gravel was mixed with the soil in different proportions in order to determine the least quantity that might be used to advantage. As was to be expected, where the maximum amount was used the road was in the best condition, but it was found that for such soil even a small amount was a material benefit to the road. The work done was as follows: One mile of road prepared for hauling; 2,200 ft. dragged and ditches improved; 2,000 ft. graded, ditched and graveled. The cost of the work was:

Hauling gravel, 250 cu. yds. at 48c	$120.00
Labor	260.00
Incidentals	29.15
Total	$409.15

The gravel was furnished in the pit, free of charge. Mr. Cooley gives the following as a fair estimate of the cost of road construction per mile, without graveling, in that vicinity, for a 16-ft. roadway with ditches 10 ft. wide:

Removing sod, 20 ft. wide, 979 cu. yds. at 10 cts	$ 97.90
Turnpiking, per mile	225.00
Total	$322.90

He states that such a road, carefully constructed, with good ditches, graded to a perfect line, and all sod and vegetable matter eliminated, could be maintained with the ordinary road drag or planer at a cost of $5 per mile per year.

A committee of the city council of Havana, Cuba, has reported favorably on the plan submitted by Governor Magoon, for paving and sewering the city at a cost of $15,000,000.

Characteristics of Wire Rope Tramways with Some Figures on Cost of Operation.[*]

BY W. S. GEMMERT.[†]

I propose to give only a brief description of the leading systems of aerial wire rope transportation, which I shall endeavor to make free from technicalities, and yet sufficiently clear to enable one to grasp the principles involved with a probable view of applying them to his own requirements. The method is adapted for transporting all classes of material such as coal, rock, ore, sand, clay, timber, fruit, light merchandise, etc., over practically any length of line. When a tramway line attains a length of several miles it is customary to divide it into sections, the number of sections depending on various conditions, such as length of line, capacity and irregularities of the ground. When the gradient in favor of the load is sufficient, a tramway becomes self-acting. The descending loaded carriers not only give off sufficient power to haul up the empties but develop a surplus energy which can be used to advantage in operating light machinery. When power is used to drive a tramway the actual amount required is governed principally by the capacity, friction, and the difference in elevation between the loading and discharging terminals.

Tramway systems may be divided into two distinct types. First, the Double Rope System, and, second, the Single Line Tramway. The Double Rope systems may then be sub-divided into three varieties, namely, the Friction Grip Type, the Detachable Clip System and the Permanent Attached Clip System. The Single Line System is an English invention, while the Friction Grip Type originated in Germany. The two Clip systems are American inventions and bid fair to gradually replace all other systems.

The distinguished features of the double rope tramways are the two stationary track cables upon which the loaded and empty carriers travel, respectively, and an endless moving traction rope for propelling these carriers. The track cables are securely anchored at the loading terminal and supported at intervals along the line by towers located dependent upon the profile of the ground. The tension on both standing and traction cable is maintained by means of weight boxes located at the discharging terminal. The track ropes are carried in grooved saddles mounted on the top caps of the towers, while the traction rope is supported by guide sheaves with self-lubricating phosphor bronze bushings, requiring no oiling.

The friction grip system is employed principally in cases where it is desired to load material from a series of bins. In cases where it is possible to load from one bin, the clip system is far more preferable.

The friction grip system is so called from the fact that each bucket is equipped with a friction grip or clutch which seizes the running traction rope and remains attached thereto by means of friction.

This system might be further subdivided into two classes, one in which the friction is created by an eccentrically operating lever, locked and released automatically, securing a constant friction that is independent of the ascending or descending angle; second, one in which the clutch exerts friction on the traction rope by a lever on which the weight of the bucket is transmitted. This friction varies with the cosine of the angle the line forms with the horizontal. In general appearance the clip system resembles the friction grip type, only it is more automatic in its mechanism, thereby reducing the amount of attendance and this in turn reducing the cost of transportation to a minimum.

Friction grip tramways ordinarily require from three to ten men or more to handle an output varying from 200 to 500 tons per day, while the same output on a clip system can be handled with one or not more than two men. This is a very important feature, considering that the expense for labor is a fixed charge. For this reason alone the clip system is gradually replacing the friction grip type in many instances.

As stated before, there are two varieties of clip systems, one in which the bucket is detached automatically for loading, and in the second case the loading is accomplished by means of an automatic loader which does not require the bucket to be detached from the moving traction rope.

The single line tramway system is the simplest in design, consisting of one endless traction rope, the same passing around horizontal sheaves at each end of the line, and a multiple of buckets, the same being permanently attached to this moving rope. In other words, this endless rope in the single line tramways replaces the two ropes in the double rope system. This style of tramway is limited in capacity, the ultimate capacity being approximately 15 to 20 tons per hour. In view of this fact the double rope system is more advantageous as it is also because of the possibility of increasing the capacity from time to time as the developments of the mine increase. Quite a few manufacturing concerns have discontinued manufacturing the single line tramway, making this system rather obsolete, hence further comment is unnecessary.

The question now arises as to the cost of a tramway and what would be the minimum cost of transportation. For an example to illustrate this I might refer to an automatic double rope tramway installed about two years ago for the Hicks Clay Co., Drake, Ill.

When the management of this company opened up their clay banks at Drake one of the most serious propositions confronting them was how to transport the material to the railroad, the clay bank being located 1,500 ft. from the tracks. Transportation methods of various kinds were considered, including railways, small portable track systems, and lastly the aerial tramway system. After carefully considering the details of the various systems presented, particularly from the cost standpoint (not necessarily the initial cost), the management finally decided upon installing a wire rope tramway. This plant has a capacity of 250 tons per day, and being 1,500 ft. in length with about four supporting towers, the complete cost installed ready for operation was approximately $3,500. One man handles the entire output from, which you can readily figure that the cost of transportation per ton, assuming that the attendant were paid $2 per day, would amount to less than 1 ct. Now, in addition to this fixed cost of transportation we must add for the depreciation in the plant, which we will say will be at the greatest figure not more than 1 to 2 cts., or even assuming that it would run as high as 4 cts., the cost of transportation would be but 5 cts. per ton. No other system would compare favorably with this type of transportation, transporting material at the figures just mentioned.

The type of tramway installed for the Hicks Clay Co. is what is known as the detachable bucket system. In this style of tramway one bucket remains stationary at the loading point while the rest of the line is in operation. As the bucket enters the loading station it is detached automatically from the clip on the traction rope, the clip passing on picks up automatically the stationary loaded bucket at this terminal. In other words this operation is simply detaching one bucket from the clip and attaching another bucket to take its place. This operation is repeated continuously and no attendant is required except the one who manipulates the levers controlling the flow of the material from the bin into the buckets. This loaded bucket now travels over the line to the discharging station at which point an automatic trip engages the latch handle, releasing it automatically and permitting the bucket to discharge its contents into the bin. This being a self-dumping, self-righting, and self-locking bucket, it performs all these functions without the assistance of any additional machinery, and after being discharged the bucket travels on around to the loading station where the operation of loading is repeated.

In cases where the length of the tramway is increased over that mentioned above the cost per foot is considerably less. For instance we will assume that we have a tramway proposition one mile in length. The cost of installing a plant of this type, under the same general conditions, would be approximately $10,000. This can be accounted for in this manner: Regardless of the length of the tramway, in each case there is a fixed charge, namely, the cost of the two terminal stations, which is the

---

[*] Extracts from a paper in the "Iowa Engineer," Ames, Ia., January, 1908.

[†] Chief Engineer, Broderick & Bascom Rope Co. St. Louis, Mo.

[illegible] part of the tramway on account of the automatic machinery used. The cost of transportation is the same whether the system is 1,500 ft. or 5 miles long.

What is the limit of transportation by means of a system of this kind. There is practically no limit, as a tramway may be installed and operated as successfully over 50 miles or more as it could over 1 mile.

In erecting propositions of this kind it is customary to divide the line into sections, each section being approximately 4 or 5 miles in length, depending on the contour. In case of a power proposition each section would be driven independently by the necessary power appliance, which may be electric, steam or a gas engine. There are tramways throughout this country and foreign countries 25 miles or more in length, and operating very successfully.

At this point it may be well to refer to the second, or permanent attached clip system, employing an automatic loader. The general distinguishing features of this system are practically the same as the type described as installed for the Hicks Clay Co. with the exception that the stationary bucket at the loading station is eliminated, and in its place is used a two-compartment automatic loader. This contrivance consists of two compartments, each holding one-half of the capacity of the bucket. The tramway is continuously in operation, and the attendant at the loading station manipulates the ore gates levers permitting the material to flow from the ore bin into the loader and waits for the incoming bucket. This bucket enters the loading station and by means of actuating levers or an accelerator, the automatic loader is placed in commission at a speed that is gradually increased by means of these levers until at a certain point both bucket and loader travel at the same speed. At this instant the automatic mechanism is brought into play, the gates of the loader open and the material automatically flows into the bucket. This is all accomplished while the loader travels through a space of approximately 10 ft. At the end of this distance the loader is automatically detached, the bucket passes out over the tramway line and the loader recedes to its former position, where, recharged, it remains stationary until the next incoming bucket picks it up, where it again passes through the same operation. To one who has never seen a system of this type work it is hardly possible to imagine the advantages that are obtained, and to use the words of such a person watching this loader work, "It is almost human in its operation."

A word might be stated as to the size of buckets used on a plant of this kind. Ordinarily [illegible] having a capacity of 7 cu. ft., but in many instances buckets as large as 25, 30 and 40 cu. ft. in capacity are used. This all depends upon the kind of material to be transported and the capacity desired.

Catalogs Worth Having

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in *Engineering-Contracting*. If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers.

No. 0695. **Light Locomotives.**—H. K. Porter Co., Pittsburg, Pa.

This cloth bound book of 225 pages should be read by every user of light locomotives, as it not only gives in excellent form catalog data of a wide range of light locomotive sizes but contains some 80 pages of tables and useful information for railway work. According to the catalog the company is now prepared to build locomotives up to 17-in. cylinder diameter. Indeed the range of sizes and designs shown is remarkable.

No. 0696. **Tie Plates.**—The Hart Steel Co., Elyria, O.

This 45-page pamphlet illustrates and gives dimensions of the several styles of tie plates marketed by the company named. Particular attention is directed to the McKee rolled steel, longitudinal flanged, shoulder tie plate which is made both with plain and corrugated tops. A feature of this plate is that the plate is thickened or reinforced at the shoulder to strengthen it against buckling at this point of greatest stress. This is claimed to be the only longitudinal flanged shoulder plate which has this feature.

No. 0697. **Memindex Memorandum Books.** Wilson Memindex Co., Rochester, N. Y.

This pamphlet describes and tells how to use the special loose-leaf memorandum book made by the company named. The system is very flexible and should prove useful to contractors and engineers.

No. 0698. **Blue Printing Supplies and Machinery.**—C. F. Pease Blue Print Machinery & Supply Co., Chicago, Ill.

This 36-page pamphlet lists a complete line of blue and brown print papers, tracing cloth and papers, blue print frames, cars, working and drying machines, lamps, brushes, filing cases, etc. The Franklin continuous printing, washing and drying machine is described in detail. These machines make the prints, wash, potash and dry them and deliver them on the cutting table ready for immediate use.

No. 0699. **Thermit Welding of Pipe and Rods.**—Goldschmidt Thermit Co., New York, N. Y.

This 11-page pamphlet illustrates and describes the apparatus used in thermit welding rods and pipe and explains by an example the sequence of operations giving full directions for such operation. Estimates of cost are also given.

No. 0700. **Raydiant Sidewalk Lights.**—The Berger Manufacturing Co., Canton, O.

This is an unusually good descriptive catalog. The several styles of prisms are clearly explained and the general construction of vault, sidewalk and other lights is described. The text then takes up materials of construction, tells how to order them and gives directions in detail for installing various kinds of lights. Numerous views of actual installations are shown. A section of the pamphlet, which contains 48 pages, is devoted to the company's multiplex steel plates for flooring, steel studding, expanded metal, etc.

No. 0701. **Standard Methods for Testing and Specifications for Cement.**—Universal Portland Cement Co., Chicago, Ill.

This is the 32-page pamphlet edited by the Secretary under the direction of the Committee on Standard Specifications for Cement of the American Society for Testing Materials. It contains the reports of the Committee of the American Society of Civil Engineers on Uniform Tests of Cement, the above named committee on Standard Specifications for cement and the Committee of the Society for Chemical Industry on Methods of Analysis for Limestones, Raw Materials and Portland Cements. As an introduction the Secretary has prepared a chronological record of the actions of the several societies leading to these reports. Cement testers and users should secure copies of this pamphlet.

Personals.

The Vulcan Iron Works Co., of Toledo, O., has changed its corporate name to the Vulcan Steam Shovel Co.

The Power and Mining Machine Co., has removed its San Francisco office from 118 First St., to Room 217 Sheldon Bldg.

Mr. Isham Randolph, Consulting Engineer, has moved his offices to Suite 718 First National Bank Bldg., Chicago, Ill.

The general offices of the American Locomotive Co. have been moved to the Cortlandt Bldg., 30 Church St., New York.

Mr. Hamilton Johnson has been appointed City Engineer of Jackson, Miss., to succeed Mr. W. G. Kirkpatrick, resigned.

Mr. C. C. Boyer has been appointed Assistant Engineer of the Gulf, Colorado & Sante Fe Ry., with headquarters at Galveston, Tex.

The Sales Department of the Iola Portland Cement Co., on and after April 29 will be located at Suite 815 Commerce Bldg., Kansas City, Mo.

Mr. C. I. Longnecker has been appointed Chief Engineer of the Brown-Cockran Co., Lorain, O., manufacturers of gas engines, marine motors and refrigerating machinery.

Mr. F. E. Mackle has been appointed manager of the recently organized Southern Erecting Co., of Jacksonville, Fla. The company will engage in the construction of steel bridges, buildings, etc.

Dr. Charles Richard Van Hise, President of the University of Wisconsin, will deliver the class day address to graduates of 1908 of the Michigan College of Mines.

Major Herbert Deakyne, Corps of Engineers, U. S. Army, has been detailed to report to Major James C. Sanford, Corps of Engineers, at Philadelphia, Pa., for temporary duty.

Mr. Charles W. Harper, 322 E. 28th St., New York, has been promoted from the position of Topographical Draftsman, Bureau of Sewers, Borough of Brooklyn, to the position of Assistant Engineer in that Bureau.

Edward R. Lowe, Manager of the Lowe Wrecking & Diving Co., died April 16 at his home in Brooklyn, N. Y., aged 60 years. Mr. Lowe was well-known as a submarine engineer and contractor, among his works being the construction of the foundation of the old Croton Dam.

Professor Frank Soule, since 1872 dean of the College of Civil Engineers, University of California, has retired and has been made Professor Emeritus by the Board of Regents. Professor Charles Derleth, Jr., at present Associate Professor Structural Engineer will succeed Professor Soule as Professor of Civil Engineering.

A society to be known as the Canadian Society of Forest Engineers has been organized to include all foresters in the Dominion. The officers of the society are as follows: President, Dr. B. E. Fernow, Toronto, Ont.; vice President, E. H. Campbell, Ottawa, Ont.; Secretary-Treasurer, F. W. H. Jacombe, Ottawa, Ont.

Mr. B. B. Gordon has resigned as Chief Engineer of the Colorado Southern, New Orleans & Pacific R. R., the Beaumont, Lone Lake & Western R. R., and the Orange & Northwestern R. R., and his duties will be assumed by Mr. C. W. Fisk, Engineer of Maintenance of Way, with headquarters at Beaumont, Tex.

Civil Engineer Harry H. Rousseau, U. S. N., of the Isthmian Canal Commission and Miss Gladys Squires, daughter of the American minister to Panama, were married April 4. Lieut. Rousseau is in charge of the Department of Municipal Engineering, Motive Power and Machinery, and Building Construction on the Isthmian Canal.

The Appalachian Engineer Association will hold a meeting May 2 at Fairmont, W. Va. Among the papers to be read at the meeting are the following: "Practical Phases of Centrifugal Mine Pumps," Mr. O. K. Baker, of the Freeborn Engineering Co., of Kansas City, Mo.; "Electrical Distribution in Shops from Central Stations," Prof. C. R. Jones, West Virginia University; "Common Faults in Concrete Construction," Mr. A. Wagner, Chief Engineer of the Newport News Light & Water Co.; "The Upper Freeport Coal Bed," Mr. Ray V. Hennen, Assistant Geologist, West Virginia Geological Survey; "The Failure of a Concrete Bridge and the Action of the Embankment Abutting It," Mr. H. S. Moreland, Resident Engineer, Rochester, Syracuse & Eastern Ry., Clyde, N. Y.; "The Relation of the Locating Engineer to a Modern, Low-Grade, Trunk Line," Mr. G. D. Brooke, Assistant Engineer, B. & O. R. R., Morgantown, W. Va.; "The Electrification of Steam Railroads."

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, Chicago
Telephone Harrison 675

NEW YORK OFFICE: 13 21 Park Row
Telephone 5613 Cortlandt

BOSTON OFFICE: 170 Summer Street
Telephone 5882-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . . . PRESIDENT
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance) — ***$2.00*** *a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*

$2.50 *a year (52 issues) to Dominion of Canada.*

$3 00 *a year (52 issues) to all other countries*

ADVERTISING RATES ***sent on application.***

Copy for regular advertising must be received not later than Friday preceding date of issue in which it is to appear. "Proposals," "Wants" and "For Sale" announcements can be inserted as late as Tuesday morning.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

How Can I Get Started in Contracting with Small Capital?...........255
The Seven Sections of Reading Matter in ENGINEERING-CONTRACTING...255
What Kind of Catalogs to Write, and the Business Success that Comes from Advertising a Good Catalog Properly 256

CONCRETE SECTION:

Tests of Cast Iron and Reinforced Concrete Culvert Pipe.............257
A Novel Concrete Mixer...........262

EARTH AND ROCK SECTION:

Cost of Diamond Drilling in British Columbia 263

ROADS AND STREET SECTION:

Cost Data on Experimental Oiling of New York State Highway, Together with a Report on the Results Attained 265
Some Data on the Cost of Street Sweeping 267

WATER WORKS AND SEWER SECTION:

A Novel Piece of Outfall Sewer Construction, Chicago, Ill.............269
The New Ohio Law Governing Water and Sewage Purification and Stream Pollution 270

RAILWAY SECTION:

The Itemized Cost of the Great Northern Railway System as Estimated by Its Chief Engineer................271

STRUCTURAL STEEL SECTION:

Methods of Erecting a Steel Arch Bridge 275

GENERAL ARTICLES:

Method and Cost of Lock and Dam Construction by the U. S. Government on the Upper White River, Arkansas 278

METHODS AND COSTS:

"How Can I Get Started in Contracting with Small Capital?"

In various forms this question comes to us repeatedly. We purpose offering suggestions, from time to time, on "how to get started." The "start" is, after all, the most difficult part of a business campaign to plan, yet it is a subject seldom discussed by men who are offering advice on methods that lead to business success.

One successful contractor got his start by buying a steam roller, paying down some $600 in cash and giving his notes for the balance. He learned to run the roller himself and rented the roller to road builders, receiving $5 a day for the use of the roller and $3 a day for his own services.

This scheme of buying a machine and renting it by the day, or, better still, taking sub-contracts, is one that has been successfully used as the first step in building up many a contracting business. There is more than one large railway contractor who started originally with one small steam shovel.

To illustrate the opportunities in this line, we call attention to our advertising columns. One advertiser offers a small steam shovel, especially designed for city work, such as the excavation of basements. Three other advertisers have trench excavators. There is every reason to believe that the owner of such a machine could keep it busy subcontracting trench work. When not thus occupied, he could drum up a job of draining land with it.

The writer once operated a small dredge—a bantam affair—and found no difficulty in keeping it busy reclaiming swamp land and the like.

In our advertising columns will be found a description of a comparatively new type of road or pavement in which oil or tar is mixed with earth and consolidated with a rolling tamper. This roadway has been extensively used for years in suburban streets. The contractors get their contracts largely from real estate companies that desire an economic, dustless roadway, and the contractor usually names his own price with little or no competition. The plant is simple and not expensive. The process is equally simple.

Another advertiser is placing a reinforced concrete pile on the market and is offering to give exclusive territory on a royalty basis.

Another advertiser has a drainage machine which he offers to lease. In this case the problem is to find land that needs drainage, awaken the owners of the land to the possibilities, and secure for yourself the contract of doing the drainage on a unit price basis, cost plus a fixed sum, or otherwise.

The point we wish to make is simply this: Don't wait for money and opportunity to come to you, but go out and discover or create the opportunity, even though it be on a small scale to begin with. Equip yourself with an efficient plant, even if you have to take in a silent partner to furnish part or all of the modest capital with which to start. Study the advertising columns and the catalogs to find possible avenues for your efforts. Self-assurance and a persuasive tongue will get both capital and contracts for you, if you do not try to handle too big an enterprise to begin with.

The Seven Sections of Reading Matter in Engineering Contracting.

Civil engineering and its allied business of contracting may be divided into at least six or seven sections, more or less overlapping, but nevertheless distinct. It has been the editorial policy of this journal to furnish every month some reading matter of interest to those who are specializing in any one of these "sections" of civil engineering, whether as engineers or as contractors. It has not always been practicable to obtain good reading matter for each section every week. However, the number of our subscribers has grown rapidly and steadily greater, and with this growth has come a recognition of the merits of this journal among advertisers. Tardy though the recognition has been and incomplete as it still is, we are glad to be able to announce that seven sections will be published regularly in the future and under specific section headings. The titles of these seven sections are as follows: (1) Concrete and Reinforced Concrete Section; (2) Earth and Rock Section; (3) Roads and Streets Section; (4) Waterworks and Sewers Section; (5) Structural Steel Engineering Section; (6) Railway Section; and (7) Unclassified and General Articles.

ENGINEERING-CONTRACTING is the only strictly civil engineering and contracting journal in America covering the general field of civil engineering completely and covering no other field. Certain of our contemporaries aim to supply reading matter for electrical, mechanical, mining and civil engineers.

We believe that there is and always will be a field for such journals at one extreme, and we believe that, at the other extreme, there is and always will be a field for journals that specialize in certain branches of civil engineering. But between these two great extremes is the field that we have chosen for ENGINEERING-CONTRACTING.

It is true that all the professions of engineering overlap to a certain degree. The civil engineer is concerned more or less with electrical engineering. The mining engineer should be familiar with certain phases of civil engineering practice. If this is so, how much more necessary is it for civil engineering specialists to have a journal that covers not only their own specialties but those of their brother civil engineers. Let us make this point clearer by an illustration. A reinforced concrete culvert is designed by a

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

way engineer, is built by a contractor specializing in concrete, and the design is adopted, in all essentials, by a railway engineer for a railway culvert. Here are three specialists in civil engineering, yet all interested in the same structure, in the methods of its construction and in the costs, while at least two of them are equally interested in the design. Every reader can multiply examples of this sort without number. Clearly, then, there is great need of just such a journal as ENGINEERING-CONTRACTING. Moreover it is a well known fact that civil engineers and contractors are repeatedly shifting from one "specialty" to another. A railway engineer today, a city engineer tomorrow, and a general contractor the year after. Such are the changes of occupation that are the rule rather than the exception in the practice of civil engineering. While it is true that somewhat similar changes occur in the four great engineering professions—civil, mechanical, mining and electrical—they are the exception rather than the rule.

This has been our reasoning in mapping out a policy to be followed in editing ENGINEERING-CONTRACTING. The remarkable growth of the paper has justified the attempt to produce a journal covering the whole field of civil engineering to the exclusion of other engineering fields.

In this editorial, as elsewhere, we include contracting when speaking of civil engineering, for there is really no hard and fast line of demarcation. The successful contractor is a good deal of a civil engineer, whether trained in an engineering college that gives diplomas or whether educated in the great laboratory of field practice whose diploma is honest work, economically performed.

What Kind of Catalogs to Write, and the Business Success That Comes From Advertising a Good Catalog Properly.

There are now some 220 advertisers who take space regularly in ENGINEERING-CONTRACTING. (Two years ago there were only 34 advertisers in this journal.) Our advertisers are finding that whenever they produce a good advertisement of a good catalog they immediately reap a harvest of requests for it, which proves beyond doubt that we have a great many readers who are keenly interested in their products. The object of this editorial is to assist *all* our advertisers in getting the same remarkable results that *some* of our advertisers have secured.

The writer has written a good many catalogs for manufacturers in different lines and has prepared hundreds of advertisements. He has "keyed" the advertisements and has learned what kinds of advertisements "pull" returns. He has observed the rapid growth of the business of certain advertisers in contrast with the slower growth of others. He has studied the causes. He believes he understands the fundamental principles of successful advertising in trade journals. It is his purpose, therefore, to discuss the subject of advertising in a series of editorials, of which this is the beginning.

What is the first principle that should be applied in conducting a successful advertising campaign in the so called trade journals? In the writer's judgment *the first thing to do is to produce a catalog containing such interesting and valuable reading matter that it will be preserved as a book of reference.* This is ordinarily the last thing that most advertisers consider. Advertisers commonly say that what they want is "inquiries" and then their salesmen will attend to interesting the prospective purchaser.

The writer believes this to be a serious error. Readers do not ordinarily make inquiries for catalogs unless they become interested through advertisements. It is impracticable to tell as much about any product in an advertisement as in the catalog itself. Hence the catalog should be written very much as a good engineering book is written. It should explain the many uses to which the machine or product can be put, the methods of using the machine or product, the methods of keeping the machine in good working order, the economy of machine work over hand work, the dimensions, weights, capacities and prices of the machine or product, etc. The writer recalls getting one of the catalogs of the Ingersoll Drill Co. some 20 years ago. It was really a small text book on drilling. He kept that catalog for many years among his engineering books and referred to it again and again. The writer cannot help believing that the present standing of the Ingersoll-Rand Drill Co. is due very largely to the production of such catalogs as that one was.

Within recent years the practice among most manufacturers has been to produce catalogs that are principally picture albums. Reading matter has been largely eliminated, the argument being that a busy man hasn't time to read, but that he will look at pictures. Now we are strong believers in picture albums, but we are stronger believers in reading matter of the right sort as a means of getting and holding the interest of the busiest of business men.

Said one advertiser recently: "I don't care to tell much about my product in my catalog. I much prefer to let my salesman answer all questions." But suppose the salesman never gets a chance. Suppose the prospective purchaser gets a competitor's catalog that *does* tell him a lot about the product. Suppose he *keeps* that catalog but throws yours away. Suppose he refers to that catalog at different times and brands your competior's name on his brain every time he does so. Suppose he is very favorably impressed with your competitor's product, sends for a quotation and never gives your salesman a chance to explain. Well, these very suppositions are realities every day of the week. The writer knows it from his own experience as a purchaser as well as from his experience in advertising.

If the full truth were known about catalog writing, it would be found that, in most cases it is treated as a disagreeable job to be got off one's hands in the quickest fashion possible. It is easy to turn over a lot of photographs to an engraver with an order to retouch them at so many dollars per photograph and to make half tones of such and such size. But it is not easy to sit down and write a small book of reading matter on the same subject, and write it in a fashion that will interest the reader. Hot air and generalities will not interest a reader. Neither will technical descriptions of mechanism. What the machine will do, and how to do it, and at what cost—those are the things that a reader wants to know primarily. Then he wants to know wherein your product differs from others, and the advantages you claim as arising from those differences. Finally he wants tables of sizes, capacities, and list prices. Do not forget the prices. There may be a discount from the prices, but make the discount comparatively small, so the reader can use the prices as they are given in making his rough preliminary estimates. Credit him with sense enough to send for net quotations when he reaches the point where he is about to buy, also give him credit for not being fool enough to be misled by any criticism of your printed prices coming from a competitor.

Having written your catalog—and it need not be a large one to be so valuable as to merit preservation—what is the next step in your publicity campaign? The writer has found that the best thing to do, as a rule, is to *advertise the catalog and not to send it promiscuously to any mailing list.* There are those that object to mailing expensive catalogs to any one who may ask for a catalog. They call it "promiscuous giving" of matter that has cost money. Promiscuous? What, indeed, is less promiscuous than the sending of a trade catalog to a man who is interested enough in the subject to write for one? We contend that no method of catalog distribution is less promiscuous. Hundreds of thousands of dollars are wasted annually in sending catalogs to "mailing lists" on the bare chance that a few of them will not find an immediate grave in the waste paper basket. If a man is not enough interested in a catalog to send for it when it is properly advertised, the chances are a hundred to one that he will promptly throw it away if you send it to him unasked. It is true, of course, that many catalogs bring no direct returns even when sent by request. Thus, an engineer frequently gets a catalog of contractor's machinery, and makes no purchases himself because he may not be in the employ of a contractor. Yet that same engineer may be, and frequently is, the only man on the job who has a library of engineering books among which are to be found catalogs. The writer has been consulted times without number by contractors on construction work as to the best machines for given purposes, and has put his catalog files at the contractor's disposal. Therefore, do not make the mistake of assuming that because no direct returns can be traced to a catalog sent on request you have not made a rich profit by sending it.

In advertising a catalog, "key" your advertisements and thus ascertain the *relative merits* of the different journals as advertising mediums for your product. You will frequently be amazed at the results. Journals that have seemed to you distinctly second rate, judging by the number of advertising pages, will be found to have more readers interested in your product than journals that have previously stood higher in your estimation. Certain other journals will "fall down" completely, showing that their claims of large circulation are purely claims.

As to the *absolute worth* of your advertising, be not too hasty in reaching a conclusion. If you have taken space in all journals that merit a trial, and if none of them brings many returns, you may safely infer that your catalog is not what it should be. One advertiser of a certain product received in one day 45 inquiries for his trade literature, which he could trace to ENGINEERING-CONTRACTING, breaking every record previously secured from other journals. And his subsequent steady returns likewise have broken all records. On the other hand, another advertiser in the very same field, while expressing satisfaction with our paper, since it stands relatively ahead of others, has expressed disappointment at the *absolute* returns traceable to all his advertising in different journals. Why this difference? One need but to read the trade literature sent out by these two firms to find the answer. The one produces about the best and most interesting trade books and pamphlets to be secured anywhere. The other evidently pays little attention to catalog writing and relies entirely upon its salesmen to interest and convince the prospective customer. The one advertises its trade literature extensively and intelligently. The other does little advertising of its catalogs and is a great believer in the use of "mailing lists." The contrast is striking. Both get good results in securing business, but there is not the slightest doubt that with good catalogs, well advertised, the second of these firms would add greatly to its business

In our next editorial on advertising we shall discuss the different methods of "keying" advertisements, and shall take up some of the technicalities of writing advertisements.

The State forests of Switzerland yield about 64 cu. ft. per acre; the corporation forests about 42 cu. ft.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Tests of Cast Iron and Reinforced Concrete Culvert Pipe.*

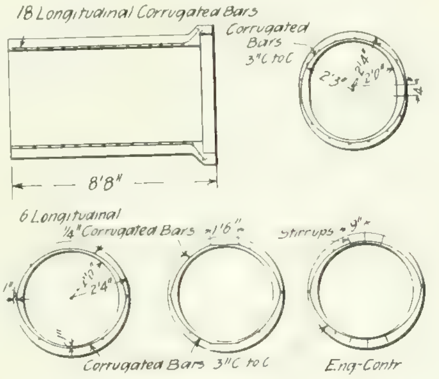
III.

TESTS OF REINFORCED CONCRETE PIPE.

BY ARTHUR N. TALBOT.†

Five reinforced concrete culvert pipes were furnished by the Chicago, Burlington & Quincy R. R. They were made at Montgomery, Ill. Owl brand Portland cement was used. The gravel came from a pit at Montgomery. A mechanical analysis of the gravel is given in Table I.

In two pipes the reinforcement was ¼-in. corrugated bars, placed as shown in Fig. 1, and ½-in. corrugated bars were used in one pipe. One pipe was reinforced with "Clinton Wire Mesh," No. 3 wire being used, and the fifth pipe was reinforced with fence wire laid in the center of gravity of the concrete. The steel, which was placed lengthwise of the pipe, is not considered in figuring the reinforcement. To allow the steel to be made circular in shape, the pipes were made with the vertical diameter 4 ins. longer than the horizontal.



18 Longitudinal Corrugated Bars
Corrugated Bars 3" C to C
2'3"
2'4"
2'0"
4
8'8"
6 Longitudinal ¼" Corrugated Bars
1'6"
Stirrups
9"
1"
2'0"
2'4"
Corrugated Bars 3" C to C
Eng-Contr

Fig. 1.

The rings were all circular in section, 4 ft. inside diameter and 2 ft. long, the reinforcement being placed as shown in Fig. 1. The reinforced rings, of which there were sixteen, were 4 ins. thick, while the eight plain concrete rings were made 6 ins. thick. In most of the rings the steel was shaped somewhat like an ellipse in order to bring the reinforcement near the tension side at the quarter points. In Nos. 934, 971, and 972 the bars were flattened for a distance of 18 ins. at both top and bottom of the ring, and in Nos. 976 and 977 three crimped pieces of steel were placed at top and bottom across the ring. These were spaced 9 ins. apart and served the same purpose as stirrups in a beam.

The testing machine used was the same as that used for testing the cast iron pipe. (See Eng.-Contr., April 29, 1908.)

Data of Tests.—Table II gives manner of loading of the plain and reinforced concrete rings and pipes and the loads carried. Table III gives the results of the concentrated load tests and Table IV the results of the distributed load tests. These will be discussed for the two methods of loading under different heads.

In Figs. 2 to 5 are given diagrams of the amount of the vertical and horizontal deflections of the pipe and rings which were produced by the load per lineal foot of length of pipe indicated by the vertical scale. A single full line shows the change in the vertical diameter. Where two lines are given, the full line shows the change in the horizontal diameter, and the dotted line the change in the vertical diameter. These diagrams will be discussed for the two methods of loading.

Concentrated Load Tests.—The methods used in testing the cast iron rings and pipe were used for the tests on concrete and reinforced concrete rings. As the plain concrete rings broke before there was an appreciable deflection no measurement of deflections was made. The modulus of rupture calculated from equation (7) (see Eng-Contr., April 22, 1908) is given in Table III. All failures occurred in either the top or bottom section of the cylinder, as is to be expected from the relative value of the bending moment at these points and that at the extremities of the horizontal diameter. The breaks were sudden and the load which could be carried after this break was very much less than the load at the time of the formation of the cracks.

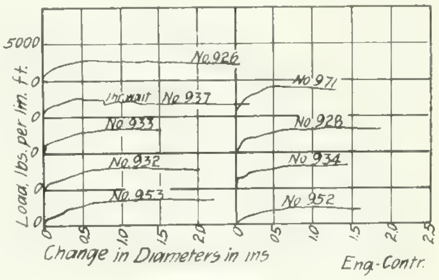


Fig. 2.

The reinforced rings deflected considerably before final failure. At a load of 1,000 to 2,150 lbs. per lin. ft., fine cracks appeared on the tension face, generally at top or bottom, much as they appear in tests of reinforced concrete beams. With the application of higher loads, numerous fine cracks appeared on the tension faces at the top, bottom, and sides. Two forms of critical failure were apparent; one a tension failure of the reinforcing bar at the top or bottom of the ring (stretching beyond the yield point of the metal) and the other a failure of the concrete by the stripping and shearing of the concrete from the tension face. The latter form of failure may correspond to the diagonal tension failure in beams. Sometimes the concrete was split off along the reinforcing bars and these bars were straightened from their original circular form. The following notes are typical of the tests:

---

*Condensed from a paper read before the Western Society of Engineers, April 15, 1908.

†University of Illinois, Urbana, Ill.

Table I.—Mechanical analysis of gravel used in reinforced culvert pipe:

	PER CENT PASSING.			
Sieve No.	Test No. 1.	Test No. 2.	Test No. 3.	Average.
¾	90.5	93.8	91.0	91.8
½	77.1	81.5	78.1	78.9
⅜	63.0	68.4	65.8	65.7
3	50.7	58.0	55.0	54.9
5	35.4	43.7	40.2	39.8
10	33.4	41.5	38.3	37.7
12	33.1	41.1	37.8	37.3
16	32.0	40.4	37.2	36.5
18	31.7	39.4	36.1	35.7
30	29.6	36.1	32.9	32.9
40	23.4	28.4	26.0	25.9
50	9.0	10.5	10.1	9.9
74	5.1	6.4	6.0	5.8
150	1.3	1.9	1.7	1.6

No. 932. Fine cracks at top, bottom and sides at 1,500 lbs. per lin. ft. At the maximum load of 3,000 lbs. per lin. ft. the deflection was 0.85 in. Later the concrete began to strip off.

Table II.—Concrete and reinforced rings and pipe—Data of tests:

No.	Age at Test Days.	Manner of Loading.	Critical Load, lb.	Maximum Load, lb.
		RINGS.		
901	37	Concentrated	. . .	5,000
902	36	Concentrated	. . . . .	3,900
907	40	Concentrated	. . . .	5,600
908	35	Concentrated	. .	5,200
911	42	Concentrated	. . . .	3,000
912	41	Concentrated	. . .	4,200
903	36	Distributed	7,100	61,000
906	34	Distributed	9,600	88,000
926	32	Concentrated	. .	5,700
928	44	Concentrated	. .	7,100
931	31	Concentrated	.	5,000
932	37	Concentrated	. .	6,000
933	34	Concentrated	.	6,350
934	98	Concentrated	. .	6,300
952	36	Concentrated	. .	4,700
953	15	Concentrated	. . . .	7,200
971	93	Concentrated	. . . .	8,250
923	36	Distributed	14,000	21,000
921	41	Distributed	20,000	47,000
922	38	Distributed	20,000	37,000
927	36	Distributed	16,000	52,000
951	38	Distributed	18,000	50,000
972	88	Distributed	16,000	35,000
976	92	Distributed	18,000	38,000
977	90	Distributed	20,000	42,000
		PIPES.		
985 6	. .	Distributed	. . . .	200,000
981	. .	Distributed	166,000	268,000
982	149	Distributed	129,000	215,000
983	118	Distributed	106,000	202,000
988	183	Distributed	76,500	262,000
987	92	Distributed	76,500	202,000

No. 934. A fine crack appeared at the top at 1,300 lbs. per lin. ft., at the bottom at 1,550 lbs. per lin. ft., and at the sides at 2,050 lbs. per lin. ft. At 3,050 lbs. per lin. ft. the deflection was 0.73 in. and at the maximum load, 3,150 lbs. per lin. ft., it was 1.05 in. and the cracks at the top and bottom soon opened up 0.25 in., showing tension failure.

No. 952. A fine crack appeared at the bottom at 1,000 lbs. per lin. ft., at the sides at 1,250 lbs. per lin. ft., and at the top at 1,450 lbs. per lin. ft. At a load of 2,250 lbs. per lin. ft. the deflection was 0.97 in. At the maximum load, 2,350 lbs. per lin. ft., the concrete split off and the rods broke through at the top.

No. 971. Fine cracks appeared at the top and bottom at 1,500 lbs. per lin. ft. and at the sides at 1,750 lbs. per lin. ft. At the maximum load, 4,120 lbs. per lin. ft., the deflection was 0.6 in. Failed by tension in the steel at both top and bottom.

In Table III the bending moments at the maximum loads are given. In part of them, failure came by splitting of the concrete along the reinforcing bars. In some cases this was caused by imperfect fabrication, the bars being left too close to the interior face of the ring. The deflection curves have much the same characteristics. The maximum load gave a deflection of 0.5 to 0.8 in.

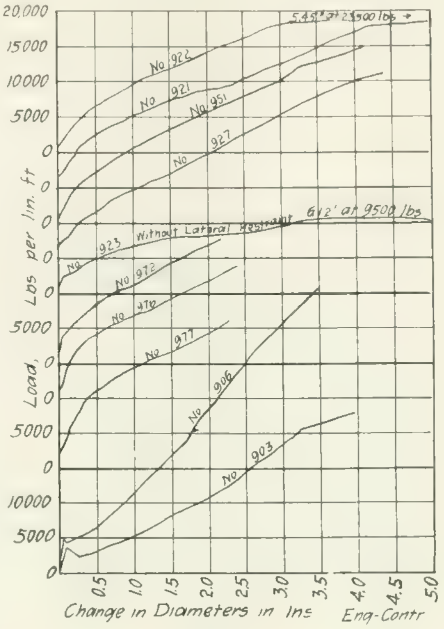


Fig. 3.

Distributed Load Tests of Concrete Rings.—The plain concrete rings which were tested under a distributed load, bedded and covered with sand and restrained at the sides as already described, cracked at the bottom, top and sides at an early load. With the continued application of the testing apparatus the load dropped off at first until at a somewhat greater deflection sufficient side restraint had been developed when the load again increased and continued to rise until a considerable change had been made in the vertical and horizontal diameters when the test was discontinued. The load-deflection diagrams are given in Fig. 3. The following are notes of the tests of the two plain concrete rings.

No. 903. At a load of 3,550 lbs. per lin. ft. and a deflection of 0.09 in., a crack appeared at the bottom and the load dropped off to 2,150 lbs. per lin. ft. The indications were that the pressure of the sand of the bed was not well distributed. As the loading head was run down, cracks appeared at the east side of the ring at a load of 2,150 lbs. per lin. ft., the crack at the bottom opened to 0.0625-in., and a crack formed at the top of the ring. At 2,500 lbs. per lin. ft. the crack at the bottom had opened to 0.25 in. As the deflections were increased, the indicated load increased, and the cracks at the top, bottom, and sides increased in width, though the amount of the opening of the cracks at the sides could not well be measured. At a load of 8,000 lbs. per lin. ft., and a deflection of 1.45 in., the crack at the bottom was 0.5 in. wide and that at the top 0.25 in. At 13,000 lbs. per lin. ft. another crack appeared at the west side 6 in. above the horizontal diameter, and crushing of the concrete at the extremities of the horizontal diameter became apparent. The crack at the bottom was 0.75 in. wide and that at the top 0.5 in. At 23,000 lbs. per lin. ft. a crack appeared on west side somewhat above the horizontal diameter. At 30,500 lbs. per lin. ft. the vertical diameter was 3 ft. 7.5 in. and the horizontal 4 ft. 4.5 in. The test was discontinued, although the ring was still taking an increasing load.

No. 906. At a load of 4,800 lbs. per lin. ft. and a deflection of 0.03 in. a crack appeared at the bottom. At 4,950 lbs. per lin. ft. one appeared at the top. The load fell off to 4,250 lbs. per lin. ft. At a deflection of 0.3 in. and a load of 5,050 lbs. per lin. ft. cracks formed at the sides. These cracks gradually widened as the deflections and loads were increased. A new crack appeared at one side 8 in. above the extremity of the horizontal diameter at 15,500 lbs. per lin. ft. and one in a similar place on the other side at 20,500 lbs. per lin. ft. The crack at the bottom was 0.25 in. wide at a load of 10,500 lbs. per lin. ft., 0.5 in. at 30,500 lbs. per lin. ft., and 0.75 in. at 40,500 lbs. per lin. ft. and that at the top was 0.1875,—0.625 and 1 in. at the same loads. At the maximum load of 44,000 lbs. per lin. ft. there was crushing at the sides, and a circumferential crack formed. The vertical diameter was 3 ft. 8.5 in. and the horizontal 4 ft. 3.5 in.

No. 977. Fine cracks appeared at top at 4,000 and 6,000 lbs. and at the bottom at 7,000 lbs. per lin. ft., and more at 8,000 lbs. Bottom cracks were gradually opening at 9,000 lbs. per lin. ft. Failure by tension in steel at top and bottom was apparent at 16,000 lbs. per lin. ft. No signs of bars pulling away. Crushing of concrete at 20,000 lbs. per lin. ft. Test discontinued at 21,000 lbs. per lin. ft.

It is evident that in these tests after the cracks appeared the rings did not act as a single structure but instead formed four pieces under equilibrium somewhat as shown in Fig. 6. Without adequate lateral restraint, equilibrium would not be maintained, and if the elasticity of an embankment failed, stability would be lost. With the lateral pressure maintained, failure occurs by crushing of the concrete.

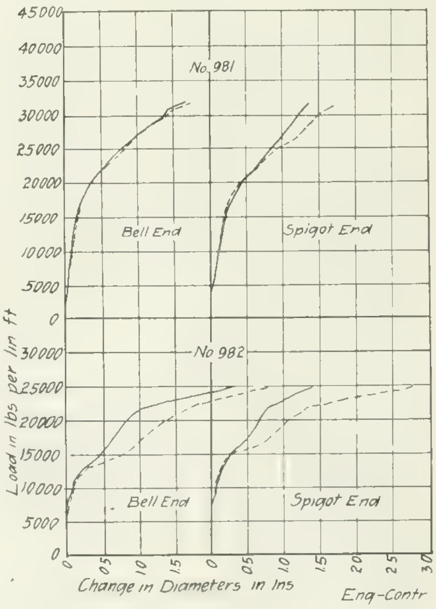


Fig. 4.

Distributed Load Tests of Reinforced Concrete Rings.—The tests on the reinforced concrete rings and pipe followed the method used in the tests of the cast iron rings and pipe. The reinforced concrete rings were tested in the small box, using the 600,000-lb. testing machine, and the reinforced concrete pipe were tested in the hydraulic jack machine.

In the reinforced concrete rings cracks

appeared early in the test on the tension side at the top and bottom, but the load continued to increase, and from this point to a load of, say 15,000 lbs. per lin ft., the reinforced concrete rings were much stiffer than the plain concrete rings and were evidently acting as reinforced concrete structures. During this stage numerous cracks appeared at the top, bottom, and sides similar to the tension cracks found in the test of reinforced concrete beams, and these increased in size. In part of the rings the cracks at the top and bottom increased in width to such an extent as to show failure by the steel becoming stressed past its yield point. In a number of the rings this did not occur, but instead the concrete was stripped or split off over the bars by the bars straightening out and pulling away from the interior concrete. In a few cases this was due to poor fabrication, the bars being placed too close to the inner surface, but evidently this feature is a source of weakness to such construction. In No. 972, in which the bars at the top and bottom were made with a much flatter arc, and in Nos. 976 and 977, in which stirrups were used, stripping of the concrete did not develop and the steel was stressed beyond its yield point. This occurred also in No. 923. In all cases after the yielding of the steel or the stripping of the concrete the action of the ring in the test was much the same as in the tests of the plain concrete rings, and there seems to be no characteristic difference either in the loads or the amount of deflection except that the cracks did not open up wide at the sides and the angular displacement was distributed over a larger number of cracks. This view is borne out by the fact that for this stage of the test the deflections for all the reinforced concrete rings fall (see Fig. 3) between the lines for Nos. 903 and 906, the two plain concrete rings. It is evident that the action of the ring in the latter part of the test is much the same as that of the plain concrete rings, in that equilibrium is maintained by the lateral restraint of the sand and that the integrity of the structure is based upon the development and the maintenance of this lateral pressure. The following are notes of the tests.

TABLE III.—CONCRETE AND REINFORCED CONCRETE RINGS.

No	Load at 1st Crack lb. per lin. ft.	Maximum Load lb. per lin. ft.	t inches	Modulus of Rupture	M 0.16 Wd	M₀ 0.87 Atf	Ratio M₀/M¹
CONCRETE RINGS.							
901	2,500	2,500	6	300			
902	1,950	1,950	6	234			
907	1,900	1,900	6	228			
908	2,300	2,300	6	276			
911	1,500	1,500	6	180			
912	2,100	2,100	6	252			
REINFORCED CONCRETE RINGS.							
926	1,500	2,850	2.75		23,700	26,600	1.12
928	1,400	3,550	2.5		29,500	24,200	0.82
931	2,150	2,500	2.75		20,800	26,600	1.28
932	1,500	3,000	3.0		25,000	29,100	1.16
933	1,170	3,170	2.0		26,400	19,400	0.73
934	1,300	3,150	2.5		26,400	24,200	0.92
952	1,000	2,350	2.0		19,600	19,400	0.99
953	1,200	3,600	2.25		29,900	21,800	0.73
971	1,500	4,120	2.75		34,500	26,600	0.77

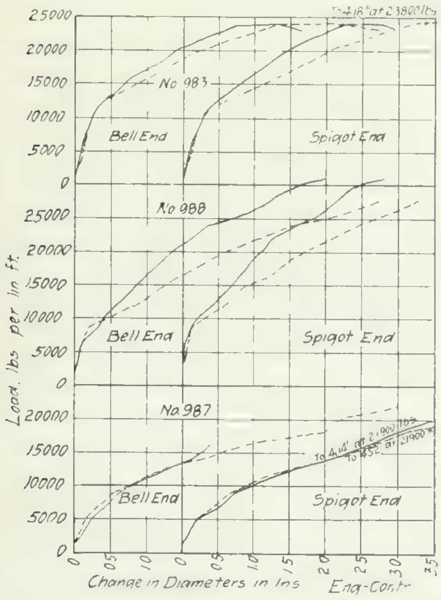


Fig. 5.

No. 921. A fine crack appeared at the bottom at 3,500 lbs. per lin. ft. at a deflection of 0.14 in., two more at 4,500 and one at top at 5,000 lbs. per lin. ft. The concrete began breaking off at the bottom at 5,500 lbs. and at the top at 7,000 lbs. per lin. ft. The rods broke through and the concrete stripped off at 9,000 lbs. per lin. ft. Circumferential cracks appeared at a load of 13,000 lbs. per lin. ft. and others appeared at higher loads. Crushing at sides noticed at 16,500 lbs. per lin. ft. and was crushing freely at a load of 23,500 lbs. per lin. ft., when the deflection was 5.5 in.

No. 922. Fine crack appeared at bottom at 3,500 lbs. per lin. ft. and one at top at 3,500 lbs. per lin. ft. Other cracks appeared at top and bottom at from 4,500 to 6,500 lbs. per lin. ft. and at sides at 7,500 lbs. per lin. ft. Rods broke through concrete at 12,500 lbs. Load continued constant at 18,500 lbs.

No. 923. In this test the rods holding the sides of the box were loosened at times, leaving little side restraint. The load then would not increase until there was sufficient increase in the diameter to bring added pressure against the ring. A fine crack appeared at the bottom at 2,250 lbs. per lin. ft. and one at the top at 3,000 lbs. per lin. ft. Crushing at sides at 8,000 lbs. per lin. ft, and circumferential cracks formed. At 10,500 lbs. per lin. ft. one rod broke out at bottom. Test discontinued.

No. 976. Fine cracks appeared at top and bottom at 4,000 and 6,000 and 7,000 lbs. per lin. ft. Three tension cracks finally opened up wide at the bottom and two at the top. No evidence of bars pulling away from the ring. Crushing began at 19,000 lbs. per lin. ft.

TABLE IV.—CONCRETE AND REINFORCED CONCRETE RINGS AND PIPES.

No.	Load at 1st Crack lb. per lin. ft.	Critical Load, lb. per lin. ft.	t inches	M¹ Wd/16	M₀ 0.87 Atf	Ratio, M₀/M¹	Maximum Load, lb. per lin. ft.
CONCRETE RINGS.							
903	3,550						30,500
906	4,800						44,000
CONCRETE PIPE.							
985 & 986	2,000						40,000
REINFORCED CONCRETE RINGS.							
923*	2,250	7,000	2.50	22,700	24,200	1.06	10,500
921	3,500	10,000	2.50	32,500	24,200	0.74	23,500
922	3,250	10,000	2.50	32,500	24,200	0.74	18,500
927	3,250	8,000	2.50	26,000	24,200	0.93	26,000
951	3,200	9,000	2.50	29,200	24,200	0.83	25,000
972	4,500	8,000	2.75	26,000	26,700	1.03	17,500
976	4,000	9,000	3.00	29,200	29,000	0.99	19,000
977	4,000	10,000	3.00	32,500	29,000	0.89	21,000
REINFORCED CONCRETE PIPES.							
981	8,360	19,500	3.00	63,500	34,700	0.55	31,500
982	10,960	15,000	3.00	48,800	72,600	1.49	24,800
983	4,950	12,500	3.00	40,600	34,700	0.86	23,800
988	6,700	9,000	3.00	29,200			31,400
987	4,950	9,000	3.00	29,200			23,800

*No lateral restraint.

Distributed Load Test of Pipe.—The results of the distributed load tests of reinforced concrete pipe are quite similar to those of the tests of rings. Fine cracks became visible on the inner surface at the top and bottom at loads from 5,000 to 11,000 lbs. per lin. ft., the amount of the load depending upon the percentage of reinforcement, and numerous fine cracks soon formed. Circumferential cracks appeared at loads somewhat greater, generally next to the bell. At higher loads the cracks became somewhat larger, though they did not open up until much later and in several cases in place of tension cracks opening diagonal shear cracks appeared, similar to those found in tests of reinforced concrete beams. There was evidently a change in the character of the load deflection diagram at this time, and the critical load given in Table IV is somewhat above the changes here noted. The amount of the deflection of the pipe at the time of the critical load averaged about 0.4 in. In several cases stripping of the concrete from the reinforcing bars at the top and bottom of the pipe occurred as in the tests of rings, but it generally appeared later and was not so serious as in the case of the rings. The ac-

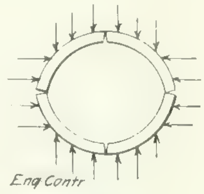


Fig. 6.

tion of the pipe at loads beyond the critical load above referred to was quite different from that at previous loads, but the reinforcement evidently acted to hold the concrete together in the four quarters and the pressure was concentrated near the edge at the four quarter points, the pipe being held from total failure by the lateral restraint formed by the pressure of the sand at the sides of the pipe in much the same way as has already been described for the reinforced concrete rings. Crushing of the concrete began to take place at the sides and top at loads near the maximum load, and after the vertical deflections had increased to 3 or 4 ins., this crushing became marked, the load dropped off, and the test was discontinued. The following are notes of the tests:

Pipe No. 981. This pipe, which was reinforced with ¼-in. corrugated bars, was given a preliminary loading in the testing box, the load being applied through I-beams used as levers, the center of the load was placed so that it was 11-in. closer to the bell than was the center of the pipe. In this test cracks first became visible at top and bottom at a load of 8,100 lbs. per lin. ft. These cracks extended from end to end of the pipe. Others appeared at top and bottom as the deflection increased, and circumferential cracks appeared in the bell at 11,100 lbs. per lin. ft. The loading was increased to 11,600 lbs. per lin. ft. at which point the I-beams commenced to buckle and the test was discontinued.

This pipe was afterward tested to destruction in the hydraulic jack machine. This time the load center was 8 ins. off the pipe center toward the bell. The cracks above noted reopened and large radial and circumferential cracks appeared in the bell at a load of 18,800 lbs. per lin. ft. At 21,500 lbs. per lin. ft. one crack in the bottom was quite large from end to end and at 27,000 lbs. per lin. ft. crushing of the concrete commenced on the inside. Large pieces fell off the bell, exposing the steel, when 29,700 lbs. per lin. ft. was reached, and at 30,600 lbs. per lin. ft. the maximum was reached and the test discontinued.

Pipe No. 982. This pipe was reinforced with ½-in. corrugated bars and was 149 days old at the time it was tested. This pipe was heated by steam coils to accelerate its hardening and examination showed that the concrete was somewhat injured thereby. It was loaded 8 ins. off the center. At a load of 11,000 lbs. per lin. ft. circumferential cracks appeared at top and bottom in the bell, and hair cracks appeared at top and bottom in the spigot end. The cracks opened up wider as the deflection increased and at 18,500 lbs. per lin. ft. crushing commenced inside the bell end, soon extending from end to end of the pipe. At 22,200 lbs. per lin. ft. diagonal cracks appeared at top and sides somewhat like shear cracks and soon crushing commenced on both sides about 20 degrees above the horizontal diameter. At a load of 25,000 lbs. per lin. ft. the test was discontinued.

Pipe No. 983. This pipe was reinforced with ¼-in. corrugated bars. The load center was 5 in. off the pipe center toward the bell. Tension cracks developed at the top in both ends at a load of 4,900 lbs. per lin. ft. and a crack appeared at the bottom at 6,700 lbs. per lin. ft. These cracks opened up wider and cracks appeared in the bell at a load of 10,400 lbs. per lin. ft. Crushing commenced on both sides at 21,600 lbs. per lin. ft. and at 23,400 lbs. per lin. ft. the maximum, an average change in the vertical diameter of 3.03 in. was noted, which increased rapidly as the load was held on the pipe.

Pipe No. 987. This test was made with the load 2.5 in. off center. This pipe, which was reinforced with fence wire, cracked end to end at both top and bottom at a load of 4,950 lbs. per lin. ft. At 6,800 lbs. per lin. ft. radial and circumferential cracks appeared all through the bell. As the deflection increased the cracks opened wider and when a load of 10,500 lbs. per lin. ft. was reached crushing commenced on both sides near the bell and immediately extended end to end of the pipe. The bell commenced breaking away from the barrel at 20,000 lbs. per lin. ft. and a maximum was reached at a load of 23,800 lbs. per lin. ft. The appearance of this pipe in the latter stages of the test indicated that the load was applied over a small portion of the surface, thus approaching a concentrated load. This may be the explanation of the large deflection found in this test.

Pipe No. 988. This pipe, which was loaded 1.5 in. off center toward the bell, was reinforced with Clinton wire mesh, the wire being No. 3. The first fine cracks appeared in both top and bottom and extended end to end at a load of 6,700 lbs. per lin. ft. At a load of 12,300 lbs. per lin. ft. the first cracks had opened wider and shear cracks were appearing in the bottom of the spigot end. At 16,000 lbs. per lin ft. shear cracks opened in the top of the bell and tension cracks opened at both ends in the sides of the pipe. Crushing then started on the inside and a maximum was reached at a load of 30,900 lbs. per lin. ft.

Comparison and Discussion.—Table IV gives the loads at the appearance of the first crack, the maximum load carried, a so called critical load, and a comparison of the critical load with the resisting moment of the pipe or ring acting as a reinforced concrete structure. By the first crack is meant the first crack which was observed, a very fine crack similar to the fine cracks which appear in reinforced concrete beams and which did not interfere with the strength or durability of the structure. The critical load is taken at the point where there is a marked change in the direction of the load deflection diagram and where it becomes more nearly a straight line. There was at or about this load a noticeable change in the pipe, shown by the tension cracks enlarging or by the shear cracks formed. It seems evident that up to this point the resistance of the pipe is that of a reinforced concrete beam and that beyond this critical load the action of the reinforcement is principally to hold the parts of the ring together and the main resistance is the compressive strength of the concrete at the top, bottom, and side points against pressure induced by the arch action made by the lateral pressure and restraint of the sand at the sides. This view is corroborated by the amount of deflection and by the similarity of action and of deflections in the tests of the plain concrete rings. The column headed t gives the average distance from the center of the reinforcing bars to the compression face of the concrete at the top and bottom. No allowance has been made in the calculations for the greater size and stiffness of the bell. The column headed M' gives the bending moment calculated from the critical load on the basis that the load is evenly distributed over the horizontal section and that there is no side restraint. The column headed M_0 gives the resisting moment as a reinforced concrete beam by the formula $0.87\,A\,f\,t$ and is based upon the strength of the steel at its yield point as the controlling element. A is the area of the reinforcement in a length of pipe of 1 ft., t is the distance from the center of the reinforcement to the compression face of the concrete and f is the strength of the steel at the yield point, which is here taken to be 46,400 lbs. per sq. in. for the rings and 55,000 lbs. per sq. in. for the pipe. For the condition that the reinforced concrete fails by the tension of the steel at its yield point, that the load is uniformly distributed over a horizontal section and that there is no lateral restraint, the ratio of two moments should be unity. If the resisting moment due to the steel is not developed, as in the case of No. 982 where a large amount of reinforcement is used, this ratio will be greater than unity. In case that there is side restraint the effect will be to reduce the ratio to an amount less than unity, provided both the horizontal pressure and the vertical pressure are uniformly distributed. For these conditions the amount of the ratio should be $1-q$ as given in equation (5). (See Eng.-Contr., April 22, 1908.) That is to say, if the ratio is 0.75 the lateral pressure would be 25 per cent of the vertical pressure. In case the load is not uniformly distributed over the horizontal section this relation would not hold and the tendency of any concentration of the load near the center of the top of the pipe would be to give a larger ratio than would otherwise be found. This is complicated by the probability of uneven distribution of the loads along the length of the pipe.

It is noticeable that No. 982 has a high ratio. This is the pipe with the large percentage of reinforcement and made of concrete which seems to have been injured in curing. With this exception the ratios are generally less than unity and their average is not far from the average found in the distributed load tests of the cast iron pipe and rings. Ring No. 923, in which the rods were kept loosened so that there was no lateral restraint, has a somewhat higher ratio and agrees fairly well with the calculated value.

After the critical load has been passed the reinforced concrete ring will, under the conditions of the test, bear a considerably higher load than the critical load, though it must be understood that this load comes after the reinforcement ceases to act as in a reinforced concrete beam, that the cracks formed are such that the reinforcement may be exposed and the durability of the structure threatened, and that the strength of the pipe is dependent upon the maintenance of the lateral restraint of the sand at the sides.

GENERAL COMPARISON OF RESULTS.

Comparison of Methods of Loading.—The tests under concentrated load for both the cast iron (Eng.-Contr., April 22, 1908) and the reinforced concrete rings gave results which are consistent with analysis, both as to strength of the rings and as to the nature of the deflection curves and the amount of the deflection. The cast iron rings broke suddenly, but the reinforced concrete rings (as shown in Fig. 3) maintained the maximum load until the deflections had increased materially. It is evident that the reinforced concrete structure may be deflected much beyond the amount which is produced by the critical load before final failure results.

In the discussion of the tests under distributed load for both the cast-iron pipe and the reinforced concrete pipe, it was noted that the determination of the resistance of the pipe to distributed load is much complicated by the uncertainty in the distribution of the load and in the amount of lateral pressure which may be developed. It is worth while, however, to make a discussion of the observations and calculations to see what conclusions may be drawn. In Table III (Eng.-Contr., April 29, 1908) are given values of the bending moment and resisting moment developed in the cast-iron pipe, and in Table IV values of these moments for the reinforced concrete pipe. As has already been noted, the expression used for the bending moment, 1/16 Wd, is based upon the assumption that the load is uniformly distributed over the horizontal section both longitudinally and transversely, and also that there is no lateral restraining pressure. The value of the resisting moment in Table III (Eng.-Contr., April 29, 1908) is based upon the modulus of rupture determined from the tests of the cast-iron rings under concentrated load. The value of the resisting moment of the reinforced concrete pipe in Table IV is based upon the ordinary formula for strength of a reinforced concrete beam at the yield point of the reinforcement and does not consider that failure by diagonal shear or other cause may occur earlier.

Under the above assumptions the ratio of the resisting moment to the bending moment developed, as given in the above table, should be unity. If a lateral pressure acts the ratio should be less than unity and its value would correspond to the 1—q of equation. If the lateral pressure is 25 per cent of the vertical pressure, both being assumed to be uniformly distributed, the ratio would be 0.75. If, however, the load is not uniformly distributed over the horizontal section the effect would be to give a larger ratio in the calculations made than would be found if the actual distribution of the load were known and used. The effect of the bell itself may possibly make the resisting moment of the pipe smaller than is assumed in the tables.

The average value of the ratio in the table for the cast-iron pipe is somewhat less than unity. It has been suggested that the higher values of the ratio may be due to uneven bedding and distribution of the load and this is borne out by some of the observations of the test. The lower values of the ratio indicate the presence of considerable lateral pressure, and the effect of no lateral pressure upon deflections is quite apparent in the test of cast-iron pipe No. 990 and in the reinforced concrete ring No. 923 where the horizontal restraining rods were kept loosened.

Evidently there is more or less variation in the conditions of the test and probably also in the resisting strength of the pipe. In the reinforced concrete rings and pipe the selection of the critical load given in Table IV is dependent somewhat upon judgment, but the values have been compared with the conditions in the concentrated load tests and changes which may be made by different individuals would not affect the results materially. The value of the ratio of the two moments is seen to be quite similar to those given in the table for the cast-iron pipe, and its average is under unity. Evidently the conditions relating to the distribution of load and the effect of the lateral pressure are similar to those found in the test of cast-iron pipe. For high percentages of reinforcement or with steel of a high elastic limit, like drawn wire, the pipe is likely to fail by other forms of failure than through the steel being stressed beyond its yield point.

In the reinforced concrete pipe beyond the so-called critical load the action of the structure, as has already been stated, is quite different and the final failure is through crushing of the concrete. It would seem that this strength is available in an emergency, though the condition of the concrete in reference to cracks and defects may be such as to affect the durability of the structure.

Measure of Strength of Pipe.—From these tests it seems evident that the lateral restraint is considerable and that the pressure exerted at the sides aids considerably in holding the pipe from large deflections and thus strengthens it materially, but at the same time the apparent effect of this is largely counteracted by the lack of uniformity in the distribution of the load and the lateral pressure, which results in making the bending moment of the vertical load larger than the assumed moment reduction in the ratio 1—q below unity, which may be found in the tests, may be considered to be merely an added safeguard. It will probably be best then to use 1/16 Wd for the bending moment coming upon such a pipe when the bedding and lateral filling are well done, considering any reduction in the ratio of moments here discussed only as a margin of safety. In case of careless or indifferent bedding or filling the lack of uniformity of distribution of pressure transversely and longitudinally will require that a higher bending moment than 1/16 Wd be used.

The strength of cast-iron pipe may be calculated by using in the expression for resisting moment a value of the modulus of rupture, say 25 per cent less than the modulus of rupture obtained by breaking small beam test specimens of the same metal. The effect of the presence of the bell is somewhat uncertain, but it is quite probable that greater strength could be obtained by distributing the metal of the bell throughout the barrel of the pipe. It should be noted, too, that it is probable that the quality of the cast-iron pipe tested was better than the ordinary run of cast-iron culvert pipe used by railroads. In the tests the cast-iron pipe failed at the maximum load and the load sustained dropped off suddenly, indicating that there would be a complete collapse under a dead load.

The critical strength of reinforced concrete culvert pipe where the reinforcement does not exceed, say 0.75 of 1 per cent, and is of medium steel, may be measured by the resisting moment calculated by the ordinary beam formula. This, of course, is with good concrete. The resistance against diagonal tension and stripping of the concrete over the bars may be improved by flattening the arc around the top and bottom and possibly by the use of stirrups at these points. The actual load which the reinforced concrete pipe will take above this critical load is a great safeguard. The property which a reinforced concrete beam has of holding a load near its maximum load through a considerable deflection may be of great value in case the earth at the sides yields and the pipe must follow it to get the benefit of side restraint.

Loads and Failures.—The distributed load tests herein described were made with the filling of sand carefully placed and packed. It is evident that the condition of the bedding and filling and also the nature of the materials used in filling over the pipe will have a great influence upon the amount of load and upon its distribution. The experience in the breaking of vitrified pipe sewers is analogous. Many cases of breakage of lines of pipe sewer have been reported in diameters from 18 ins. upward. These instances have occurred in rock and clay more generally, though such failures are found in sand and quicksand. The load which will come upon such sewer pipe from the trenches will vary with the manner of filling and the nature of the soil, as has already been suggested. Failures of cast-iron pipe under high embankments have been reported. In some of these cases the loose rock which was used for filling produced high loads. The effect of the manner of filling and of the nature of the material and the cause and prevention of such breakages would make a long paper by themselves. It is hoped, however, that the discussion of this paper will bring to light instances of the failure of culvert pipe with sufficient data to throw light upon the loads which were produced by the embankment. If engineers will report the circumstances attending such failures, the height of the embankment, the condition of the bedding, the nature of filling, the nature of the materials placed in the filling, and the time which had elapsed after construction, the information will be very helpful in planning new structures, particularly where new types of construction like concrete and reinforced concrete are to be used. Such data will add much to the information given in this paper.

The city of Newton, Mass., laid 65,000 sq. yds. of macadam pavement in 1907 by day labor, the average cost per square yard being $0.40. The macadam was 4 ins. thick. Broken stone cost $1.33 per cubic yard, laborers received $1.75 per 8-hour day and $5.25 was paid per day for team and driver.

A Novel Concrete Mixer in Which a Push Cart Serves Both to Convey and to Mix the Materials.

We illustrate in Figs. 1, 2 and 3 a novel concrete mixer of great simplicity. The mixer is, indeed, nothing more than a two-wheel push cart, and a stationary mixing frame provided with hand-driven or power-driven mechanism for revolving the bowl of the cart while the wheels remain stationary. This "cart mixer," as it is called, is especially designed for laying concrete base for pavements, for concrete curbs, for manholes, for walls of buildings, and, indeed, for any concrete work where the amount of concrete to be placed in a given area is not large. The mixer frame is so light that half a dozen men can pick it up and carry it, or it may be mounted on small wheels and pushed along by two or three men. Hence the cost of moving the mixer from place to place is nominal, which is an important consideration in many kinds of concrete work. Simple as the outfit is, the economic efficiency is great, for it is clear that there is but one handling of the concrete materials from the stock piles to the place of deposit. Stone or gravel is shoveled into the cart to a given depth. Then the cart is wheeled to the sand pile, where sand is shoveled in. About half a bag of cement is next dumped upon the sand, and the cart is wheeled to the mixer frame, where water is added.

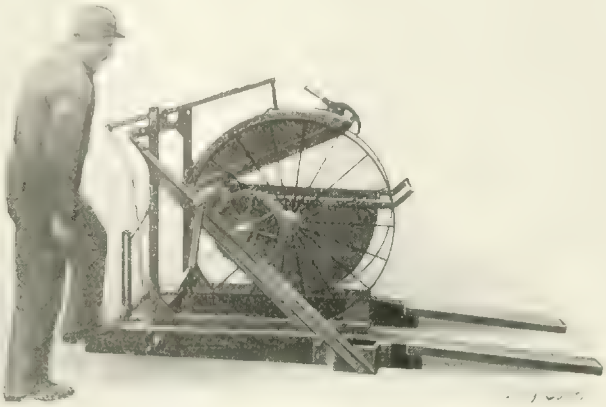


Fig. 2—Shows Hood Ready to Be Lowered Over Cart Bowl.

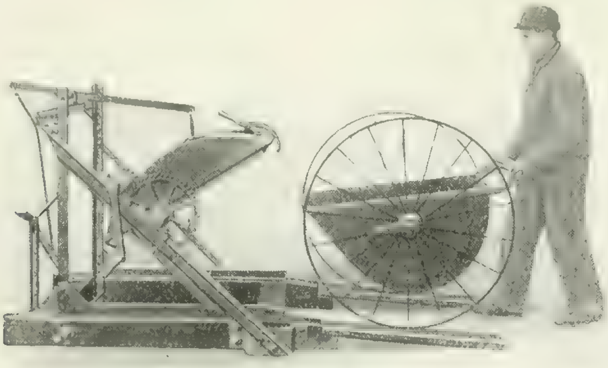


Fig. 1—View Showing Cart and Mixer Frame.

Figure 1 shows the cart going to the mixer frame. Fig. 2 shows the hood ready to be lowered over the cart bowl to which it is clamped. Fig. 3 shows a man revolving the bowl of the cart, the wheels remaining stationary, their hubs serving as the journals. The hood contains blades or scoops which facilitate the mixing. About a dozen revolutions of the bowl produce an excellently mixed concrete. Then the hood is released and the cart is wheeled away with its load of mixed concrete ready to be deposited.

The cart itself is a slightly modified form of the well known Ransome concrete cart, which holds 6 cu. ft. water measure. Every cart load can be counted upon to deliver more than 3 cu. ft. of concrete measured in place after ramming. One of these Ransome cart mixers, when operated by 6 men shoveling, transporting, mixing, dumping and ramming, can be counted upon to produce 30 cu. yds. of concrete per day, or 5 cu. yds. per man, which is practically double what is obtained by hand mixing with shovels, using wheelbarrows for delivery of materials.

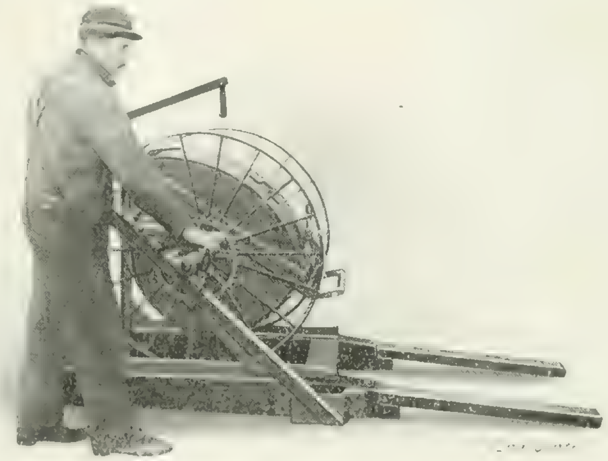


Fig. 3—Shows Bowl of Cart Being Revolved.

The mixer shown in the illustrations is one designed for hand-power, but a motor or a small gasoline engine is furnished if desired; and, where the quantity of concrete to be placed is considerable, two mixer frames may be placed side by side and driven by the same engine, thus turning out a much larger quantity of concrete and at a lower unit cost.

A feature of this mixer that merits notice is the entire absence of any inclined runways up which the concrete materials are carried. The materials are elevated only as high as a man's waist to get them into the cart, and after that they travel on practically a level plane from the stock pile to the place where the concrete is dumped. By using a coal wagon whose body can be tilted, the broken stone and sand can be chuted from the wagon directly into the push cart, and thus all shoveling is avoided. In that case at least two extra wagons should be provided to serve as storage bins. When emptied, their places are taken by full wagons.

This concrete mixer is made by the Ransome Concrete Machinery Co., of Dunellen, N. J.

The New York state legislature has passed a bill providing that assistant engineers in the city departments in New York city need have only five years' previous experience as civil engineers, instead of ten years as formerly.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Cost of Diamond Drilling in British Columbia.*

Two years ago I contributed to the Institute a paper on the results of diamond drilling as carried on at the mines of the British Columbia Copper Company, Limited, during 1905. That paper gave some details as to costs, and the period covered was but 8½ months. Since that year drilling has been carried on more or less continuously in the mines of the company, and the results of this work, so far as progress and costs are concerned, are given in detail in the following tables.

The Progress Table gives the monthly results of work as well as the yearly totals. It is of course important to know the general character of the rock drilled in order to institute comparisons with other localities. In the narrow limits of this table it is not possible to give details as to rocks, but as nearly as possible the rocks comprise diorites, compact garnetites and certain very hard and silicious eruptives

Table I Progress Table

Date.	Depth of Holes.			Hours actual drilling.	Hours moving to new holes, setting bits, etc.,	Total hours.	Number of holes.	Shifts.	Feet per shift	Feet per drilling hour.	Character of Rock.	No.	Remarks.
	Vertical feet.	Horizontal feet.	Total feet.										
1906													
Jan	170	0	170	106	46	152	6	19	8.94	1.60	Mainly hard diabase	1	1 = Hard Rocks.
Feb ..	0	191	191	104	24	128	3	16	11.93	1.83	Softer lime rock	3	2 = Medium hard rocks 3 = Soft rocks
March	332	66	398	205	77	282	5	33	12.06	1.94	Equal parts of above rocks	2	
April........	214	0	214	76	55	131	7	16	13.37	2.81	Lime rocks and ore	2	
*May	390	73	463				4				Nearly all in ore	2	
June			0..										No work in June and July.
July			0										
August	0	508	508	160	48	208	7	26	19.59	3.17	Fairly hard rock	2	
Sept ..	0	96	96	29	3	32	0	4	24 00	.31	Mainly ore	2	Drill men off on vacation.
Oct.........	195	40	235	95	53	148	4	17	13.82	2.45	do	2	
Nov.........	33	378	411	157	63	220	6	27	15.22	2.62	Hard silicious rock	1	
Dec.........	189	127	316	144	48	192	3	24	13.17	2.19	do do	1	
	1523	1479	3002	1076	417	1493	45	182	Av. 13 59	Av. C. .359			C.—Averages calculated on 3,002 ft. less 463 drilled on contract.
1907													
Jan.........	246	165	411	159	57	216	6	27	15.22	2.58	Limes and porphyry	3	
Feb.........	0	378	378	137	79D	216	2	27	14.00	2.76	'Ore and limy rock	2	D.—Several days lost moving 15 miles to another mine.
March.......	200	340	540	180	28	208	5	26	20 77	3 00	do do	2	
April........	278	186	464	181	27	208	1	26	17.86	2.56	do do	2	
May.........	67	433	500	163	53	216	3	27	18.52	3.07	Hard garnetite	1	
June..	189	288	477	187	39	226	6	26	18.34	2.55	Very hard garnetite	1	
July...	96	304	400	203	23	226	6	27	14.81	1.97	do do and diorites	1	B.—Much trouble with caving ground in August Worked two shifts nearly all the month.
Aug	497	0	497	213	129B	342	8	38	13.18	2.33	do do	1	
	1573	2094	3667	1423	435	1858	37	224	Av. 16.34	Av 2.577			

(*) This month's work was contracted as to the labor. Feet drilled are therefore not included in averages as contractor worked overtime.

Table III.—Summary of Progress.

Year.	Feet Drilled.			Hours.			Number of Holes	Number of Shifts.	Feet per Shift.	Feet per Drilling. Hour.
	Vertical.	Horizontal.	Total.	Drilling.	Moving, etc.	Total.				
1906	1523	1479	3002	1076	417	1403	45	182	13 59	2.359
1907	1573	2094	3667	1423	435	1858	37	224	16.34	2 577
	3096	3573	6669	2499	852	3351	82	406	15.285 A.	B. 2.482
		Contract Feet........	463							
			6206							

Feet used in calculating averages A. and B.

Table III —Summary of Costs

Year.	Labor.		Power.		Repairs, Oil, etc.		Diamonds.			Totals.		Feet
	Cost	Per Ft.	Cost.	Per Ft.	Cost.	Per Ft.	Carats.	Cost.	Per Ft.	Cost.	Per Ft.	Drilled.
1906	2359.65	.786	615.89	.205	330 02	.109	28.56/64	1727.65	.576	5033.21	1.676	3002
1907	2624.33	.715	1025 41	280	365 27	100	30 47/64	2322.72	633	6337.73	1.728	3667
	4983.98	Ave. .747	1641 30	Ave. .246	695 29	Ave. 105	59 39/64	4050 37	Ave. .607	11370 94	Ave. 1.705	6669
							Carats used per foot.	0 572 64				

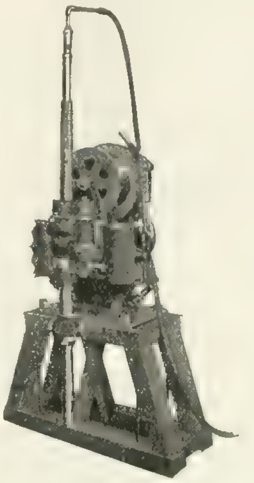
---

*Abstracted from a paper by Frederick Keffer, Greenwood, B. C., read before the Canadian Mining Institute. In addition to the data given by Mr. Keffer in his original paper, we have secured information from him as indicated.—Editors occurring in Summit camp. The medium hard rocks include all ores, and, in Deadwood camp, much of the greenstone country. The soft rocks are the limestones, porphyries and serpentines. Of all rocks drilled the garnetites proved much the most severe in diamond consumption, as is illustrated by the work from May to August, 1907, which was mainly conducted in garnetite with some silicious limestones.

Eight hours constitute a shift underground, and nine hours on the surface. On Sundays no work is done apart from repairs to machinery. In May, 1906, the labor was contracted as an experiment, but was abandoned as being unsatisfactory.

The Cost Table gives details of costs under the four groups of Labor, Power, Repairs, Oils, etc., and diamonds. The employes were, normally, a runner and a setter. Extra help was required at times for blasting places for good set ups, for laying pipe lines, moving plant, etc. In August, 1907, two shifts were employed. In June and July of that year the increase in labor costs is mainly on account of the long pipe lines required. The power consumed is taken as being equivalent to that required for a 3¼-in. machine drill, that is to say, about 20 H. P. When drilling at a mine, where for example 15 machines are used on each shift, the diamond drill is charged with 1/31 of the total power costs—it being in this instance run on one shaft only.

Where steam power is used either directly or through a steam driven air compressor, the costs are much increased. Where, as in some cases, an isolated 24-H. P. boiler was used, the power costs are still higher, as an engineer has to be provided as well as a team to haul wood.



Beauty Drill of Bullock Type.

Tools, repairs, etc., include these items as well as all small miscellaneous expenses. The increasing cost of diamonds added materially to cost per ft. in 1907.

The third table is a summary of the first two, and shows an average cost per ft. for the two years of $1.705. The carats used per ft. are 0.572/64, or in more intelligible decimals, .00893 carats, so that one carat on the average drilled 111.9 ft. All holes over 30 degrees dip are classed as vertical, and ft. per hr. in horizontal holes is about 15 per cent greater than in vertical ones. The average depth of holes is 81.3 ft., and diameter of cores is 15/16 ins.

In comparing these costs with contractors' prices, it must be borne in mind that contractors usually require air (or steam) and water to be piped to the work, and the mine must in addition furnish the air and water free of charge. In the present cost sheets all these items are charged against costs of drilling.

[The following information did not appear in Mr. Keffer's original paper.—Editors.]

The drill runner set and was responsible for the diamonds. He was paid a salary of $175 per month, while two helpers, during the period of time given, received $3.50 per day. Since the decline in the price of copper, helpers are only paid $3.30 per

TABLE II.—DIAMOND DRILLING COST TABLE FOR 1906.

Date.	Labor Cost.	Cost per foot.	Power.			Repairs, Oils, etc.	Cost per foot.	Diamonds.				Total Costs.	Total per foot.	Feet drilled	Remarks.
			Kind.	Cost.	Cost per ft.			Carats used.	Market price.	Cost.	Cost per ft.				
1906 Jan	172 00	1.012	Elec. A	36 30	.213	22.72	133	.61/64	56 53	53 99	.318	285 01	1.676	170	A.—"Electric power" is compressed air from electric driven compressors.
Feb.	152 50	.798	do	32.10	.165	7.01	036	3.47/64	"	206.70	1.082	398.31	2 081	191	Costs reckoned on assumption that diamond drill consumes as much power as a machine rock drill; that is approximately 20 H. P.
March.	292 00	.734	½ do ½ steam	112.20	.282	68.60	.172	3.35/64	60.07	213.07	.535	685.87	1.723	398	
April.	188 87	.882	Elec.	31.58	147	26.93	126	1.59/64	"	115.45	.539	362 83	1.694	214	
May	480.48	1.037	do	38.83	.083	19.41	.042	5.36/64	"	334.15	.722	872.87	1.885	463	Labor contracted this month
June															No drilling done.
July															do do
Aug.	269.25	.530	do	52.95	.104	30 67	.060	3.25/64	60.07	203.68	.401	556.55	1.095	508	
Sept.	52.85	.551	do	5.07	.053	.00	.00	.46/64	"	43.17	.449	101.09	1.053	96	Drill men on vacation.
Oct.	183.60	.781	do	51.12	.217	2.29	.009	2.19/64	61.90	141.70	.600	378.71	1.610	235	
Nov.	280.10	.681	Steam	127.42	.310	118.18	.288	2.40/64	"	160.50	.390	686.20	1.669	411	Drill operated most of Nov. and Dec. by steam direct from boiler.
Dec.	288.00	.911	Steam	128.32	.406	34.21	.108	4. 8/64	"	255.24	.808	705.77	2.233	316	
	2359.65	Ave. .786		615.89	Ave. .205	330.02	Ave. .109	28.56/64		1727.65	Ave. .576	5033.27	Ave. 1.676	3002	

TABLE II.—DIAMOND DRILLING COST TABLE FOR 1907.

Date.	Labor Cost.	Cost per foot.	Power.			Repairs, Oils, etc.	Cost per foot.	Diamonds.				Total Costs.	Total per foot.	Feet drilled	Remarks.
			Kind.	Cost.	Cost per ft.			Carats used.	Market price.	Cost.	Cost per ft.				
1907 Jan.	264 25	.643	Steam	236.24	.575	13.3	.032	1. 3/64	61.90	62.89	.153	576.75	1 403	411	
Feb.	245.10	.648	Elec.	68.60	.182	5.45	.014	1.50/64	80.00	141.70	.375	460.85	1.219	378	Great advance in price of diamonds.
March.	265.75	.492	do	53.34	.099	26.23	.049	2.37/64	"	219.14	.405	564.46	1 045	540	Best month on record for low total costs.
April.	277.90	.599	do	51 13	.110	7.3	.015	3.18/64	"	262.50	.566	598.84	1.290	464	
May.	332 00	.664	do	58.85	.117	6.38	.013	5. 4/64	"	405.48	.810	802.71	1 604	500	
June.	397 55	.833	do B	175 00	.367	47.92	.100	5.16/64	71.75	376.36	.790	996.83	2.090	477	B.—Increase in power cost due to partial closing o mine, throwing more costs on the power for diamond drilling.
July.	402 56	1 006	do B	182 25	.455	164.83	.412	7. 3/64	"	511 88	1.79	1261.52	3 153	400	
Aug.	439 22	.883	do B.	200 00	.403	93.78	.189	4.44/64	"	342.77	.689	1075.77	2 164	497	June, July and August were drilling in very hard garnetite increasing diamond consumption.
	2624 33	.715		1025.41	Ave. .280	365.27	Ave. .100	30.47/64		2322.72	Ave. .633	6337.73	Ave. 1.728	3667	

shift. The compressor men receive $4 per day.

Wood for fuel costs from $3.50 to $5 per cord according to locality and difficulty of cutting and hauling. Electric power costs $33 to $40 per horsepower per year according to locality.

This drilling was done with a Beauty drill, of the Bullock type, manufactured by the Sullivan Machinery Co. of Chicago, Ill. This machine has been in service three years and is in excellent condition. Many of the rods bought in the machine are still in service, though naturally the life of the rods is short compared to that of the drill.

The catalog price of this drill with the equipment that is furnished with it is $1,500. This does not include carbons, but does include 2 bits ready to have carbons set in them. The shipping weight of this outfit is 1,160 lbs. This drill is adapted both to mine drilling and surface drilling, as it will drill to a depth of 800 ft., making a hole 1 9/16 ins. in diameter and giving a 15/16 in. core. It is well adapted to drilling in hard rock.

Mr. Keffer estimates that with the proper usage the depreciation on this plant should not exceed 10 per cent per annum. This does not include the cost of carbons which is given in the tables. For depreciation of plant and interest at 6 per cent, a yearly charge of $240 must be added to the costs given in the tables.

Mr. James F. Fisher, city engineer of Williamsport, Pa., in his report for 1907, gives the cost of sweeping the streets by machines.

The work is done by employes of city engineer's department, the force used and the wages paid being as follows:

One team on sprinkler	$ 4.50
One team on sweeper	4.50
Two one horse pick up wagons	5.50
Four men 10 hrs, at $1.65	6.60
Total for one day	$21.10
Int. and depreciation of outfit	1.00
	$22.10

The one dollar added covers interest at 6% per annum and depreciation of the plant at 20% per year, divided by 200 working days, which is the length of the season in Williamsport.

Each day this force sweeps parts of seven streets aggregating 62,000 sq. yds. This gives a cost per 1,000 sq. yds. for cleaning by machine sweeping of 35.6 cts. The city has 206,875 sq. yds. of improved pavements, which would cost $73.65 to clean daily, or $14,730 for a season of 200 working days.

The production of lumber, lath and shingles in the United States in 1906 was 37,490,067 M feet board measure, against 30,502,961 in 1905, and 34,127,165 in 1904. The figures cover returns from 21,077 mills in 1906, 11,666 in 1905 and 18,277 in 1904.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Cost Data on Experimental Oiling of New York State Highways Together with the Results Obtained.

The experimental oiling of New York roads was undertaken by the state engineer and surveyor in July, 1906, and various methods of application were tried during August, September and October on macadam, gravel and sand roads in Oneida, Albany and Orange counties. The experiments were conducted under the supervision of Mr. Arnold G. Chapman, and it is from his report to the state engineer that the matter in this article has been taken:

The sprinkling cart used to distribute the oil on the road consisted of a 600-gallon steel tank with a wooden head, made by the Etnyer Co., fitted with a White patent oiler such as is used in California, where the sprinkler is made. The characteristic features of this type of sprinkler are that the oil is distributed directly downward upon the road surface and that the width of the application may be regulated from 18 ins. to 6 ft., as can also the amount of oil applied, by the manipulation of levers by the operator, who sits in the rear of the tank. From his position the operator can adapt the flow of oil both as to quantity and width, as the condition of the road may demand.

To unload the oil from the 6,000-gallon U. T. L. cars, in which it was received, a diaphragm pump was used, fastened to the dome of the car. By means of an iron chute the oil was conveyed from the pump to the sprinkler tank. This method was rather cumbersome and unhandy and entailed the loss of too much time in setting up the pump and in unloading the oil, but it was the best and cheapest available at that time. However, it can be greatly improved upon when the oiling is undertaken on more than an experimental basis.

The oil used was that known as the Raglan oil, obtained through the Standard Oil Co., from their wells at Salt Lick, Kentucky, at a cost of 4.78 cts. per gallon, f. o. b. at the various places where used. This is a crude oil, being black and heavy, due to the presence of asphalt, of which the producers claim a 30% to 35% base. When cold, the flow of oil is slow and sluggish, but when warm it flows with a reasonable degree of rapidity.

On the several sections of road treated the methods of application varied, some being sanded, others swept, and some treated, as left by the traffic. While the oil was being applied, traffic was not suspended, but the people chose the sides of the road not oiled, for a few days until the oil had been taken up by the surface and did not have a tendency to adhere to the vehicle tires and to be thrown upon the garments of the people riding or on vehicles. From observation during the experiments it was noted that the best results were obtained when the surface of the road was warm and dry and the day was also clear and warm.

The first section of road to be treated was the Utica-Paris macadam road in Oneida county, 5¼ miles long, on which 6,360 gallons of oil were used, the width of the surface being from 10 to 12 ft. From the end of the asphalt pavement in Utica to the top of the cemetery hill one application was given to the surface, as left by the traffic. From the cemetery south for 800 ft. a single coat of oil was used, but for the first 400 ft. the surface was sanded ¼ in. in depth, immediately after oiling, and the next 400 ft. sanded five hours after oiling. From the Casino park south 1,200 ft. the road received a double application, the second being applied during the day following the first application. From this point south to the end of the road one coating was given, the refuse on the surface having been previously swept off with a sweeper and with brooms.

The day following the treatment of the section from Washington Mills south, it rained for 12 hours; this washed some of the oil away before it had been taken up by the surface material. Where one application is referred to it is at the rate of 1,200 gallons per mile, as nearly as could be regulated by the levers of the sprinkler. Two weeks after the treatment an inspection showed the section sanded to be in better condition than the others and all the sections treated were free from any dust from automobiles passing at a high rate of speed.

The oil was received on the switch at Washington Mills, which is approximately at the center of the road, making the average haul 1.25 miles.

In figuring the cost the expense of the State labor on the work has been included. This tends to make the expense higher than it could be done for in practice, but which might be counterbalanced by the cost of transporting the apparatus from one section to another.

As 6,300 gallons of oil were used the labor cost in applying the oil was $.0095 per gallon, and as each gallon of oil cost $.0478, the total cost per gallon of the application was $0.0573.

On the basis of using 1,200 gallons per

one ter 10 ft. width the cost would be $68.76 per mile or $.0117 per sq. yd.

The cost of the applications on the Utica-Paris road was as follows:

Team (sprinkler), 2½ days, at $4	$10.00
Team (sprinkler), 2½ days, at $4	$10.00
Sweeper, 1 day, at $1	1.00
Labor (pumping and sweeping)	4.50
State labor, 7 days, at $4	28.00
State labor, expense (say)	15.00
Total	$60.50

The Loudonville macadam road in Albany county was treated for a distance of about one mile, the width of application being 18 ft. and the amount of oil used 2,300 gallons. The oil was applied to the road as left by the traffic, having a light coating of the finer wearing material upon the surface. Any oil which collected in the depressions in the road was swept out by men with brooms, who went over the road a short time after the oil was applied, thus lessening the tendency to spatter over vehicles and their occupants passing over the road after oiling. Several weeks after the oiling the road presented a surface free from dust and which was much more resilient and more agreeable than the section not treated. The average haul on this piece of work was 1.75 miles from the Tivoli St. switch at North Albany, where the car was placed.

The labor cost of the application was as follows:

Team, 2 days, at $4	$8.00
Labor, 6 days, at $1.75	10.50
State labor, 2 days, at $4	8.00
State labor, expenses	4.00
Total	$30.50

As 2,300 gallons of oil were used the labor cost of the application was $ .0133 per gallons, and as the oil cost $ .0478 per gallon the total cost of the application was $ .0611 per gallon.

For 18 ft. width, 2,300 gallons per mile cost $140.53 or $ .0133 per sq. yd.

The roads oiled in the village of Delmar were the Kenwood Ave. macadam road through the village, and the Delmar-Slingerlands macadam road. A few days previous to the application of the oil the Kenwood Ave. road and the Slingerlands road, from the railroad crossing to its intersection with the Kenwood Ave. road, had been resurfaced with ¾-in. Saratoga trap-rock, sand being used as a filler. An excess of sand had been used on the Kenwood Ave. piece, which is also very shady; these conditions, together with the fact that it rained the day following the application, made this portion sticky, and the result was not as good as on the stretch of the Slingerlands road from the railroad to the Kenwood Ave. intersection, where very little sand had been used with the stone. The length of the stretch here treated was about 1.5 miles, the width, 10 ft., 2,600 gallons of oil being used; the average haul was 0.75 mile.

The labor cost of the application was:

Team, 1½ days, at $4	$6.00
Labor, 3 days, at $1.75	5.25
State labor, 1½ days, at $4	6.00
State labor, expense	2.75
Total	$20.00

As to 2,600 gallons of oil were used it cost $ .0076 per gallon, to apply, and as the oil cost $ .0478 per gallon the total cost of the application was $ .0554 per gallon. The total cost of the application was $149.28 or $ .0164 per sq. yd.

A short stretch of unimproved sand road in the village of Elsmere was shaped with a drag harrow and then treated with oil. The length of the section was about 0.25 mile, 800 gallons being applied on a width of 10 ft. After applying the oil the road was again harrowed to mix the oil thoroughly with the sand. The average haul was 0.8 mile.

The labor cost of the work was:

Team, ½ day, at $4	$2.00
Labor, ½ day, at $1.75	87
State labor, ¼ day, at $4	1.00
Total	$3.87

The labor cost of applying the oil was $ .0048 per gallon, and as the oil cost $ .0478 per gallon the total cost of the application was $ .0526 per gallon. The total cost of the application was $42.11 or $ .0287 per sq. yd.

A stretch of 0.5 mile long on the Slingerlands road from Kenwood Ave. south was oiled for a width of 10 ft., the surface being treated as left by the traffic, 600 gallons of oil being used and the average haul being 0.5 mile.

The labor cost of the application was:

Team, ¼ day, at $4	$1.00
Pumpman, ¼ day, at $1.50	.38
State labor, ¼ day, at $4	1.00
State labor, expense	.50
Total	$2.88

The labor cost of applying the oil was $ .0048 per gallon, and the oil cost $ .0478 per gallon, making the total cost of the application $ .0526 per gallon. The total cost was $31.56, or $ .0107 per sq. yd.

The first gravel road upon which the oil was applied was the Chester-Goshen road, No. 156, this being treated for a distance of 2.8 miles. The road had been resurfaced two weeks previously, thus presenting a surface which was somewhat loose, except in the wheel tracks, where it had been firmly compacted. Several methods were used on this road, as shown in the following table. In the spring of 1906 the sections from Station 101 to Station 105 and from Station 88 to Station 91 were broken up when the frost went out of the ground, and presented a poor wearing surface. On these sections an extra heavy application was made, in order to see if the oiled surface would not protect the road-bed and lessen the action of the frost.

Station.	Width. Feet.	Approximate amount of oil applied. Gallons.
32 to 63	7½	600
62 to 83	6	450
83 to 88	9, lap 1½ in middle	125
83 to 88	9, extra heavy	150
91 to 101	7½	200
101 to 105	9, extra heavy	275
105 to 182	9, lap 1½ in middle	1,600

The total amount of oil used was 3,400 gallons, on a length of 2.8 miles, the widths varying as shown in the table; the average haul was 2.5 miles.

The labor cost of the work was as shown below:

Team, 2 days, at $4	$8.00
Pumpman, 2 days, at $1.50	3.00
State labor, 6 days, at $4	24.00
State labor, expense	15.00
Total	$50.00

As 3,400 gallons of oil were applied, the labor cost of the application was $ .015 per gallon, and as the oil cost $ .0478 per gallan the total cost of the application was $ .0628 per gallon. The total cost of the application was $ 213.52, and on the assumption that the average width of oil was 8 ft. the cost per sq. yd. was $ .0162.

No treatment was given the road before the application of oil, and from reports and the results observed a short time afterward, the dust was entirely laid and no trouble was experienced from the oil adhering to the tires of vehicles.

On the Newburgh-Woodbury road, No. 42, which is also a gravel road, but had a very hard and compact surface, 1,400 gallons of oil were applied, on a distance of one mile, the width covered being 9 ft. The road was oiled as left by traffic, the average haul being 1.75 miles.

The labor cost was:

Team, 1 day, $4	$4.00
Pumpman, 1 day, at $1.50	1.50
State labor, 3 days	12.00
State labor, expense	6.00
Total	$23.50

The labor cost of the application was $ .0167 per gallon, and the oil cost $ .0478 per gallon, making the total cost of the application $ .0645 per gallon. The total cost of the application was $90.42, or $ .0171 per sq. yd.

On Road No. 161, Newburgh-Shawangunk, a section of the completed road, one mile in length, was oiled as left by traffic, there being about a quarter of an inch of dust and fine material on the surface; 1,200 gallons were used on a strip 8 ft. wide, the average haul being 1.75 miles.

The labor cost was:

Team, 1 day, at $4	$4.00
Pumpman, 1 day, at $1.50	1.50
State labor, 3 days, at $4	12.00
State labor, expense	6.00
Total	$23.50

The labor cost of the application was $ .019 per gallon, and the oil cost $ .0478 per gallon, making the total cost $ .0668 per gallon. The total cost of the work was $80.86 or $ .0172 per sq. yd.

In the accompanying table is shown a summary of the work described in the preceding paragraphs.

REPORT ON RESULTS OF APPLICATIONS.

As stated previously the applications of oil were made during August, September and October, 1906. The results of the different methods of application were noted the next spring after the roads had been subjected to the wear of the fall traffic and the influences of winter conditions. The report was made by Mr. Chapman to Frank L. Getman, deputy state engineer, and through the kindness of the latter we are enabled to present it here. It is as follows:

SUMMARY OF WORK OF EXPERIMENTAL OILING ON NEW YORK STATE HIGHWAYS.

Road.	Material of road.	Average width oiled. Feet.	Length oiled. Miles.	Gallons applied.	Cost per gallon.	Cost per sq. yd.	Average haul. Miles.
Utica-Paris	Macadam	10 to 12	.5	6,360	$0.0573	$0.0117*	1.25
Loudonville	Macadam	18	1	2,300	.0611	.0133	1.75
Kenwood avenue	Macadam	10	1.5	2,600	.0554	.0164	.75
Elsmere	Sand	10	.35	800	.0526	.0287	.8
Delmar-Slingerlands	Macadam	10	.5	600	.0526	.0107	.5
Chester-Goshen	Gravel	8	2.8	3,400	.0628	.0162	2.5
Newburgh-Woodbury	Gravel	9	1.0	1,400	.0645	.0171	1.75
Newburgh-Shawangunk	Macadam	8	1.0	1,200	.0668	.0172	1.75

*On the basis of using 1,200 gallons per mile for a 10 ft. width.

"In commenting upon the treatment of state highways with oil as a means to prevent the dust nuisance and preserve the surface of the road I would call your attention to the results of the use of Raglan oil on sections of the state highways during 1906 and 1907.

"On the Utica-Paris road in Oneida county the dust nuisance was entirely obliterated and sections of the road which appeared to have a tendency to ravel were held together, the oil preventing the binder from being loosened and blown away. Where the road was sprinkled with a coating of sand, after being oiled, the results seemed to be more lasting, the oil and sand cushion taking the wear of the traffic for practically the whole season, thereby protecting the macadam surface, which remained solid and compact and free from ruts during the entire season.

"The section of the Loudon road in Albany county which was treated as left by traffic, although one of the main highways leading from Albany and subjected to excessive automobile use, presented a smooth and compact surface at the end of the season. As on the Utica-Paris road, the absence of ruts on the oiled section was noticeable as contrasted with the surface of the section of highway not treated with the oil.

"The section of the Delmar-Slingerland road which had been resurfaced a short time previously with ¾-in. stone, an excess of sand filler being used, did not present as favorable results. The stone used for resurfacing was of a poor quality and tended to grind up under the traffic, thus making an excess of fine material upon the surface of the road.

"The application from which the best results were obtained was that upon the Chester-Goshen road in Orange county. This section of highway is surfaced with gravel and is used as one of the main automobile roads from New Jersey through Tuxedo to the Delaware Water Gap.

"About 1,200 gals. were applied per mile for a width of from 8 to 10 ft. The road was well shaped before the application and but very little oil appeared to run off, as it is liable to do on a hard macadam surface, but was taken up by the gravel surfacing. Under the influence of traffic the surface became more compact and as it was rendered impervious to water, did not become soft and rutted after a rain.

"On several short stretches where in the previous spring the road had broken up, an extra application was made and in the spring of 1907 these sections were as compact and well bonded as the balance of the road, from which fact it can be seen that the asphaltic oil acts as a binder for the road material.

"Besides protecting the surface, the dust nuisance was entirely eliminated and the residents along the road and the traveling public spoke in the highest terms of the benefits of the oiling.

"From our use of oil on the highways we may say that the surface should be well shaped before applying and if on a macadam road, should have a thin wearing course of screenings or sharp sand spread after the application of the oil. The best results are obtained when the road is treated in hot weather, as the oil has greater penetrating qualities and can be more uniformly and easily applied.

"The benefits derived are the elimination of the dust nuisance; a compact and smoother surface free from ruts and the preservation of the road surface by the binding together of the surface materials—all of which tend to lengthen the life of the road and to make traveling more agreeable and to free the residents along the highways from the dust nuisance."

Exports of iron and steel from the United Kingdom for the first three months of the current calendar year show a decline compared with the corresponding months of last year of 279,000 tons in volume and of $9,195,251 in value.

Some Data on the Cost of Street Sweeping Taken from a Recent Report, Together with Other Data Secured by Engineering-Contracting.

During the summer of 1907 Mayor Geo. B. McClellan appointed Mr. H. de B. Parsons, Dr. Rudolph Hering and Mr. Samuel Whinery a commission to report an an improved and more effective system of street cleaning and waste disposal than is now in operation in New York City. At the end of the year this commission made its report, which has since been printed by the city.

The report covers nearly 250 pages, and has in it much valuable information on street cleaning and waste disposal. The commission has made a study of many features of this kind of work, and has collected a large amount of data on the subject. There is a great lack of literature on the subject of street cleaning, and this report, written to a great extent as a study on the subject, comes nearer to being a treatise on street cleaning than anything we have seen. The statistics and estimates given in it cannot be reproduced in a single article, but we purpose to publish data from this report in future issues..

The report discusses at some length the various methods used in street cleaning, and gives an estimated cost for each method described, thus allowing a comparison of each with the other. The estimate on hand sweeping by the "patrol method" is as follows: Cost of one outfit:

One hand cart		$10.00
Five cans for sweepings, at $2.50		12.50
Four hand brooms, at 65 cts		2.60
One shovel		.75
Two steel scrapers, at $2		4.00
Total		$29.85
Annual charges:		
Interest on outfit at 4%	$1.19	
Repairs and depreciation at 60%	17.91	
Total annual charges	$19.10	
Or for 310 days, per day		$0.062
Cost of operation per day, 1 sweeper		2.190
Total cost per day		$2.252

On the basis that one sweeper will clean satisfactorily 8,000 sq. yds. of pavement per day the cost per 1,000 sq. yds. will be 28.1 cts.

In closing their remarks on hand sweeping the commissioners said:

"A modified method of hand sweeping in use in a number of American and foreign cities consists in substituting for the ordinary push broom a small machine with a revolving broom. This machine is generally similar to the large machine sweeper, except that it is designed to pick up its own sweepings and deposit them in an attached receptacle, which is emptied when necessary. This small machine is pushed over the street by the street sweeper and does its work quite well when the street is dry. It is extensively used in Washington, where it is well liked. One objection is that on heavy traveled streets there is difficulty in working it among horses and vehicles. Upon the whole, this hand sweeping machine is not in general favor in American cities."

It is to be very much regretted that this commission of eminent engineers did not make a thorough investigation of this sweeping machine and report their findings on it. This type of machine seems to us to solve some of the problems of street cleaning, and in this article we give some data that we have collected. We realize that there can be some objection to any method, but on good pavements these machines can effect a saving over the patrol hand sweeping, and at the same time do much more efficient work.

This style of machine has been used in Washington, D. C., since the summer of 1901, and, as the commission states, "it is well liked." The name of the machine used in Washington is the "Peerless," sold by Jas. S. Barron, of New York.

Prior to the installation of these machines in Washington a patrol sweeper swept daily 7,456 sq. yds., and with the pick-up machine the same man covered 9,145 sq. yds., an increased area of more than 22 per cent. In order to compare this with the costs given above the same wages will be applied. Thus we have:

Cost of one outfit:

One Peerless hand sweeper	$75.00
Forty bags	4.00
Four upright brooms at 35 cts	1.40
One shovel	.75
One steel loosener	.40
Total	$81.55

Annual charges:

Int. on outfit at 4%	$3.26	
Four new brooms at $4	16.00	
Depreciation at 20%	16.31	
Total annual charges	$35.57	
Or, for 310 days, per day		$0.114
One man		2.190
Total cost per day		$2.304

With the area of 9,145 sq. yds. swept per day this gives a cost per 1,000 sq. yds. of 25.1 cts., or just 3 cts. less than the estimated cost of the patrol sweeping.

The working day in Washington, like New York, is 8 hrs., but the machines are only operated 6 hrs. each day, as the men spend 2 hrs. each day in picking up paper. For this purpose the men are required to go over their respective sections four times per day—the first thing in the morning, before lunch, after lunch, and towards the end of the working day. It would seem possible that this paper could be cared for in some other way. With ordinances properly enforced the greater part of it should be put into boxes on the sidewalks by the users of the street, thus preventing the paper from being scattered in the street. With the waste paper eliminated and the men employed on the machines operating them 8 hrs., the area covered per day would be between 11,000 and 12,000 sq. yds. The style of box for depositing waste paper should be somewhat similar to the package mail boxes used by the government, as the self-closing lids prevent the paper from being blown out of the boxes by the wind.

Burlap bags should likewise be used for collecting the street sweepings, instead of cans. The bags are cheaper and better adapted to the work. The dirt receptacle on a sweeper ordinarily holds the sweepings of about 800 sq. yds. When the dirt is dumped from the sweeper it can be shoveled into a bag, the bag being held open on hooks made for the purpose on the handle of the machine. The bag can be tied up and placed on the sidewalk for the pick-up wagon to carry away. With a bag it is not possible, either, for the wind or some boy to scatter the dirt as with an open top can. With the machine carrying a bag on the hooks on the handle paper can also be picked up by the operator as he passes a piece and placed in the bag. With bags a larger load, without chance of spilling any dirt, can be carried on the pick-up wagon or cart.

Upright brooms are cheaper than push brooms, and can be used with this machine, as brooms are only needed to sweep the dirt away from curbs or in taking up the sweepings after the machines have been emptied.

The steel loosener has a long handle and is used to loosen any materials that have become stuck to the pavement, the length of the handle admiting of this being done without the operator leaving his position behind the machine.

The machine uses up four brooms a year, and these have been charged in the annual expenses. The life of a machine is from 8 to 10 years, hence a depreciation of 20 per cent per year is more than ample to allow, and this will also cover renewals, as we are informed by the manufacturer that for about 200 machines used by the city of Washington the repair parts ordered during the past two years have not amounted to quite $200, or a yearly expense of less than 50 cts. for each machine.

The great problem in street cleaning is the removing of the finer particles and the dust. The commission, in its report, dwells at some length on this. The coarser particles, they state, are easily cleaned up, but even when a street has been swept there still remains the dust, which is a "serious menace to health and a destructive and discomforting element of city life." The hand pick-up sweeper does not take up all of this dust, but it does take up the greater part of it, as is evident when one walks along Pennsylvania avenue in Washington on a windy day, for it is possible to keep one's eyes open without having them filled with dust. In New York a puff of wind means a cloud of dust. On this point the superintendent of the street cleaning department of Washington, in his report dated June 30, 1902, in commenting on the work of these machines, said:

"The daily area cleaned, therefore, was not only enlarged and the expenses reduced, but the streets were kept cleaner than ever before."

With these facts of economic and successful street cleaning within the reach of all those interested, the reader will naturally ask, "Why is this hand sweeping machine not in general favor in American cities?"

The answer is not difficult to give. The aim of the American politician who controls and rules our cities and towns is to furnish work to the greatest number of men possible. These men are voters and help to keep in power the politician. A labor saving device is apt to do away with the employment of some of these voters, hence labor saving devices are not in general favor. This is not only true of this hand sweeper but it has been the case with many other tools and appliances. New York City uses a small dump cart for street and waste disposal, when a dump wagon holding from three to four times as much should be used, but these dump wagons need only two horses and a driver, while on the carts four men are needed to haul the same amount of material, hence the ward politician secures jobs for four men, and on election day he can count on four votes instead of one.

Even under these circumstances the hand sweeper should still be able to find its way, from the fact that the area allotted to one man need not necessarily be increased, but the man can be required to keep that area in a far better state of cleanliness than is now the practice.

The new engineering shops of the Univeristy of Colorado were formally opened by dedication exercises on April 25. The principal address of the day was given by Regis Chauvenet, LL. D., former President of the Colorado School of Mines. The shops are 93 x 122 ft., built in three sections with modified saw-tooth roof. The front section is two stories, the upper part being used by the General Engineering Drawing Department. Below are rooms for wood turning and wood bench work. To the rear are the lathes and other heavy machine tools for working steel and iron. Across the hall are the forge and foundry rooms, equipped with all the appliances required in modern shop practice.

The Sewer Department of St. Louis, Mo., will shortly commence the preparation of plans for diverting the River des Peres through Forest Park into a tunnel sewer through the hills. An appropriation of $1,500,000 for constructing the sewer has been voted.

Water-works and Sewer Section

Note: This section is devoted to methods and costs of constructing sewers and water-works. It will cover the construction work for all details of water supply and sewerage, including sewage purification and water filtration.

A Novel Piece of Outfall Sewer Construction, Chicago, Ill.

The accompanying drawings show a method of constructing a short length of outfall sewer which possesses some features of interest. The sewer had been completed in 1888 to the point shown by Fig. 1 about 220 ft. from the Chicago River; it was of brick and 9 ft. in diameter. From the end of the sewer proper to the river a wooden box outfall was constructed to handle the sewage temporarily until the improvement of the adjacent land made a permanent construction necessary. This permanent construction was decided upon by the Department of Public Works in 1907, and was carried out in the manner to be described.

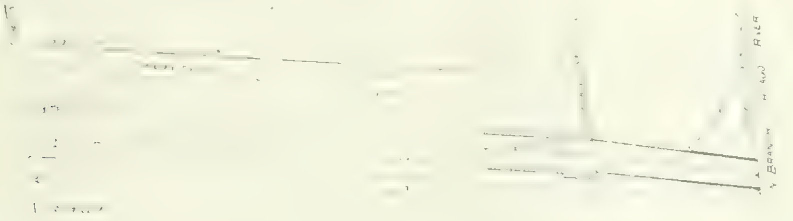


Fig. 1—Plan of Sewer Outlet, Canal Place, Chicago, Ill.

Referring to Fig. 1 it will be seen that the wooden box outfall bore away at an angle from the line of the sewer proper. It will also be noticed that the present dock line of the river is some 50 ft. beyond the established dock line to which the river will ultimately be cut. The plan decided upon was to construct the permanent sewer to the legal dock line and for the remaining 50 ft. to construct a wooden box outfall which could be torn out when the river was finally widened. Figures 2 and 3 show the details of the sewer and masonry bulkhead, and Fig. 4 shows the details of the temporary wooden box outfall. These drawings explain the construction adopted quite clearly.

The work was done by contract by Nash Bros., contractors, Chicago, Ill., at a contract price of $32.33 per lin. ft. This price included the building of the masonry outfall bulkhead, but did not include the wooden box outfall. The work presented some difficulties on account of the heavy flow of sewage in the 9-ft. sewer, which even in dry weather flows nearly half full. The first work done was to build the masonry outfall bulkhead and to construct the brick sewer back inland to the point where it intersected the old wooden box outlet. Meantime a by-pass as shown by Fig. 1 was constructed from the end of the old sewer to a connection with the old box beyond the point of intersection. The old sewer was cut into through the arch and down about to the springing line and the by-pass connected with this opening. A dam of sand bags was then put across the inside of the old sewer and the flow diverted into the by-pass and thence through the old box outlet to the river. This left the ground free for constructing the remainder of the new sewer and for connecting it up with the old work. As this construction progressed the new box outlet was constructed. Wakefield sheet piling was driven as indicated by Fig. 4, the top of the sheeting being left high enough to keep out the river. The excavation was then made and the box completed as shown. It was intended at first to do without the interior bracing, but it was found necessary to withstand the earth pressure. When the box had been completed the line of sheeting across the mouth was cut partly through from the inside with an axe and then broken out with sledges, letting in the river water. The next step was to remove the dam of sand bags, letting the sewage pass through its new channel. This lowered the flow line enough to permit the by-pass break in the old sewer arch to be repaired. The material passed through by the new sewer was unfit for backfilling and special material had to be hauled in. Where the new sewer was built alongside the old box outfall it was reinforced by the concrete saddle shown by Fig. 2. The construction work was done in three weeks. Mr. R. A. Bonnell was the engineer in charge of the work.

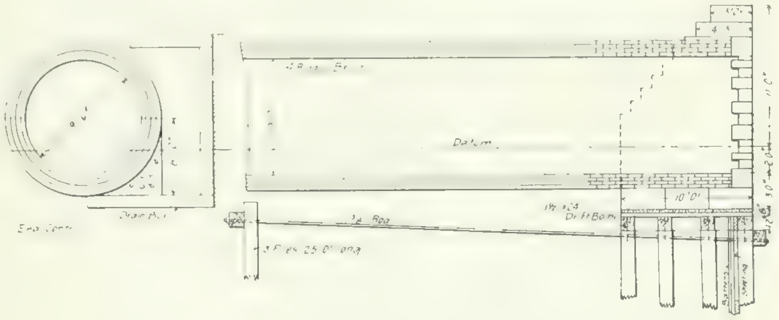
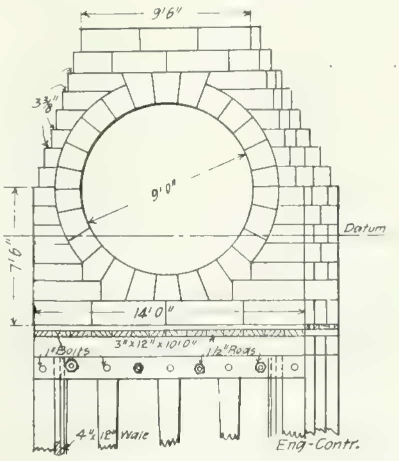


Fig. 2—Sections of Canal Place Outlet Sewer.



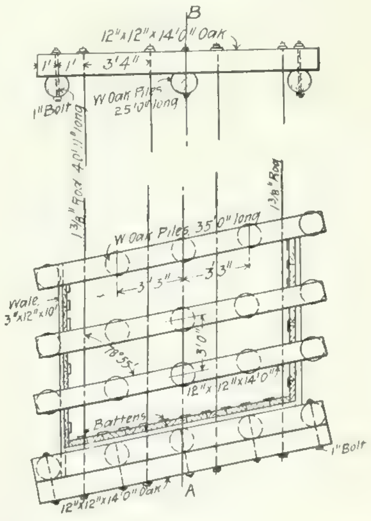


Fig. 3—Outfall Bulkhead, Canal Place Sewer Outlet.

The expenditure in forest management in Switzerland ranges from $1.50 to $7 per acre, and the net annual returns range from $3 per acre in the forests where least is expended, to $8 to $9 per acre in the city forest, where most is expended.

Somerville, Mass., constructed 5,800 sq. yds. of macadam pavement in 1907 by day labor at a cost of $0.65 per square yard, including grading. Broken stone cost $1.09 per ton on cars, and laborers were paid $2 per 8-hour day; $3.50 was the average paid for a team with driver.

The New Ohio Law Governing Water and Sewage Purification and Stream Pollution.

A sanitary enactment of particular interest to city engineers has recently been passed by the Ohio State Legislature. This gives the State Board of Health power to require the construction of water and sewage purification plants and supervisory control over such plants after construction. The full text of the law is as follows:

A BILL TO AUTHORIZE THE STATE BOARD OF HEALTH TO REQUIRE THE PURIFICATION OF SEWAGE AND PUBLIC WATER SUPPLIES AND TO PROTECT STREAMS AGAINST POLLUTION.

Be it enacted by the General Assembly of the state of Ohio:

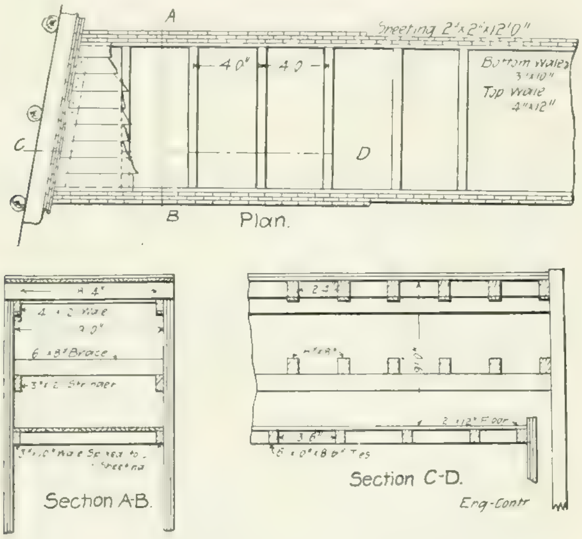


Fig. 4—Wooden Outfall for Canal Place Sewer.

Section 1. Whenever the council or board of health of any city or village, or the commissioners of any county, or the trustees of any township make complaint in writing to the state Board of Health, setting forth that a city, or village, or corporation, or person is discharging or permitting to be discharged any sewage or other wastes into any stream, water course, lake or pond and is thereby creating a public nuisance detrimental to health or comfort, or is polluting the source of any public water supply, it shall be the duty of the state Board of Health to forthwith inquire into and investigate the conditions complained of; and whenever the state Board of Health finds after investigation that the source of public water supply of any city, village or community in this state is being subject to contamination or has been rendered impure by reason of the discharge of sewage or other wastes, or in any other manner by any city, village, corporation or person; or whenever said board finds that such sewage or other wastes have so corrupted any stream, water course, lake or pond as to give rise to foul and noxious odors, or to conditions detrimental to the health or comfort of those residing in the vicinity of such stream, water course, lake or pond, it shall notify such city, village, corporation or person causing the contamination or pollution of any such stream, water course, lake or pond of its findings and give them an opportunity to be heard, and after such hearing if the state Board of Health determines that improvements or changes are necessary and should be made, it shall report its findings to the governor and attorney general, and upon their approval said board shall notify such city, village, corporation or person to install such works or means satisfactory to said board, for purifying or otherwise disposing of its sewage or other wastes, or to change or enlarge existing works in a manner to be satisfactory to said board; such works or means must be completed and put into operation within a time to be fixed by said board, which time shall be subject to the approval of the governor and attorney general. Provided that no city or village that is now discharging sewage into any river which separates the state of Ohio from another state shall be required to install sewage purification works as long as the unpurified sewage of cities or villages in any other state is discharged into said river above said Ohio city or village.

Sec. 2. Whenever the Board of Health or health officer of any city or village, or 10 per cent of the electors thereof, file with the state Board of Health a complaint in writing, setting forth that it is believed that the public water supply of such city or village is impure and dangerous to health, it shall be the duty of the state Board of Health to forthwith inquire into and investigate the conditions complained of; and whenever the state Board of Health finds after investigation that the public water supply of any city or village is impure and dangerous to health and that it is not practicable to sufficiently improve the character of such supply by removing the source or sources of pollution affecting it, or if said board finds that such water supply is being rendered impure by reason of improper construction or inadequate size of existing water purification works, it shall notify such city, village, corporation or person owning or operating such water supply of its findings and give them an opportunity to be heard, and after such hearing if the state Board of Health determines that improvements or changes are necessary and should be made, it shall report its findings to the governor and attorney general, and upon their approval said board shall notify such city, village, corporation or person owning or operating such water supply to change the source of supply or to install and place in operation water purification works or device satisfactory to said board, or to change or enlarge existing water purification works in a manner satisfactory to said board, within a time to be fixed by said board, which time shall be subject to the approval of the governor and attorney general.

Sec. 3. Whenever the state Board of Health finds, upon investigation, that any water or sewage purification works, on account of incompetent supervision or inefficient operation, is not producing an effluent as pure as might reasonably be obtained from such plant, and by reason of which any public water supply has become dangerous to health, or any stream or body of water has become offensively polluted, or has become a public nuisance, said board shall issue an order to the officers, board or department of any city or village, or the corporation or person having charge of or owning such plant, to secure an effluent as pure as might be reasonably expected from such plant and satisfactory to said board; and if such officer, board or department of any city or village, or such corporation or person fails, for a period of five days after receiving such order, to secure such an effluent, the state Board of Health shall report the fact to the governor and attorney general and upon their approval may order such officer, board or department or owner of such plant to appoint within ten days and pay the salary of a competent person to be approved by said state Board of Health to take charge of and operate such works so as to secure the results demanded by the state Board of Health.

Sec. 4. If in any case any order of the state Board of Health, when approved by the governor and attorney general, and made in pursuance to the provisions of this act, is not acceptable to any city, village, corporation or owner affected thereby, such city, village, corporation or owner shall have the right to appeal as follows, to-wit: The necessity for and reasonableness of such order may be submitted to two reputable and experienced sanitary engineers, one to be chosen by the city, village, corporation or owner to which such order of the state Board of Health applies and the other chosen by the state Board of Health, who shall not be regularly employed by said board and who shall act as referee engineers. If the engineers so chosen are unable to agree then they shall choose a third engineer of like standing, and the vote of the majority shall be final and binding. The referee engineers herein provided for shall have power to affirm, modify, or reject the order of the state Board of Health submitted to them, and their decision, as reported in writing to the governor and attorney general, which shall be rendered within a reasonable time, shall be accepted by the state Board of Health, and shall be enforced by said board in the manner provided for in this act. The fees and expenses of 'said referee engineers shall be equally divided between the city, village, corporation or owner requesting such reference and the state Board of Health.

Sec. 5. It shall be the duty of every such municipal council, department or officer having jurisdiction to provide for the raising of revenues by tax levies, sale of bonds or otherwise to take all steps necessary to secure the funds for any such purpose or purposes; and when so secured, or the bonds thereof have been authorized by the proper municipal authority, the same shall be considered as in the treasury and appropriated for such particular purpose or purposes, and cannot be used for any other purpose; provided that the bonds herein authorized to be issued for the purposes enumerated in this act shall not exceed 5 per cent of the total value of all property in any city or village, as listed and assessed for taxation, which may be in addition to the total bonded indebtedness allowable under the provisions of Sec. 2,835 of the Revised Statutes, but the question of the issuance of such bonds shall not be required to be submitted to a vote.

Sec. 6. If any council, department or officer of any municipality, or person or private corporation, shall fail or refuse for a period of 30 days after notice given him or them by the state Board of Health of its findings and the approval thereof by the governor and attorney general of the state of Ohio, to do and perform any act or acts required of him or them to be done and performed by this act, such members of council or department, and such officer or officers, or person or private corporation shall be and become personally liable for such default, and upon conviction thereof shall forfeit and pay to the state Board of Health $500 * * * to be deposited with the state treasurer to the credit of said board; provided, however, that the governor and attorney general, upon good cause shown, may, in their discretion, remit said penalty, or any part thereof.

Sec. 7. An action may be begun for the recovery of any such penalty by the prosecuting attorney of any county in the name of the state of Ohio in the court of common pleas of such county having jurisdiction of any such party or parties; or it may be begun by the attorney general in any such county or in the county of Franklin, as provided for by Secs. 210 and 211 of the Revised Statutes of Ohio.

Railway Section

Note: This section is devoted to methods and costs of constructing railways. It will cover road-bed and track construction, contractor's plant and organization, surveying methods and permanent way structures.

The Itemized Cost of the Great Northern Railway System as Estimated by Its Chief Engineer.

In our issue of April 15 we gave an estimate of the cost of the Northern Pacific Railway similar to the one that will be given here. Both these estimates were presented as testimony before the Interstate Commerce Commission in their hearing of the "Spokane Rate Case." Since the object of the hearing was to ascertain the reasonableness of railway rates on the N. P. and on the G. N. railways, the railways naturally claimed a high physical value for their property. As stated in our April 15 issue, Mr. Halbert P. Gillette, testifying in behalf of the city of Spokane, claimed that the estimates presented by the railways were much too high, frequently being high not only as to unit prices but as to quantities.

Mr. A. H. Hogeland, Chief Engineer of the Great Northern Railway, presented the following as his estimate of the cost of reproducing the railway new at present prices.

The mileage of the Great Northern under operation April 1, 1907, was:

	Miles.
Main track	6,523.09
Second, 3d, 4th, 5th and 6th track.	112.25
Side track	1,480.24
Grand total of all tracks	8,115.58

Mr. Hogeland's estimate of the cost was presented in the following summarized form:

1. Engineering		$6,870,187
2. Right of way and station grounds		87,067,532
3. Grading		93,098,889
4. Tunnels		7,447,620
5. Bridges, trestles and culverts.		17,953,028
6. Ties		18,690,731
7. Rails		31,054,392
8. Track fastenings		7,375,495
9. Frogs and switches		904,450
10. Ballast		10,509,000
11. Track laying and surfacing.		6,998,409
12. Fencing right of way		760,815
13. Crossings, cattle guards and signs		1,922,160
14. Interlocking or signal apparatus		386,190
15. Telegraph lines		2,198,283
16. Station buildings and fixtures		3,276,300
17. Shops, roundhouses and turntables		3,667,900
18. Shop machinery and tools		1,779,692
19. Water stations		1,983,325
20. Fuel stations		575,700
21. Grain elevators		2,708,100
22. Storage warehouses		276,500
23. Docks and wharves		1,222,900
24. Gas making plants		15,000
25. Miscellaneous structures		3,194,850
26. Track and bridge tools		142,877
27. Stores and supplies on hand Feb. 28, 1907		5,395,463
28. Contingencies		15,291,252
29. Equipment:		
Locomotives	$10,756,324	
Passenger cars	4,915,764	
Frt. cars and other equip.	25,249,096	40,921,184
Total		$373,688,224
30. General and legal expenses (1%)		3,736,882
Total		$377,425,106
31. Interest during constr. (10%)		37,742,510
Grand total		$415,167,616

Engineering was estimated at 3 per cent of all items requiring engineering supervision, being all items except items 2, 26, 27, 29, 30 and 31.

Right of way and station grounds were estimated by the Right of Way Department.

The grading was estimated as follows:

27,018	acres clearing at	$82.50	$ 2,228,985
340,000	square rods grubbing at	1.65	561,000
165,438,650	cubic yards earth at	0.31	51,285,982
33,973,350	cubic yards hardpan at	0.45	15,288,008
8,441,860	cubic yards loose rock at	0.55	4,643,023
12,771,060	cubic yards solid rock at	1.10	14,048,166
1,765,675	cubic yards riprap at	2.00	3,531,350
92,500	cubic yards retaining wall at	9.00	832,500
194,250	cubic yards slope wall at	3.50	679,875
	Total grading		$93,098,889

Mr. Hogeland testified that the quantities of grading were arrived at as follows: "For 82 per cent of the mileage of the system the actual quantities moved in construction were obtained from Engineering Department records. For the balance of the system the quantities could not be obtained in that way, because no records were available, and they were estimated from profiles and by comparison with adjacent portions of the system where the quantities were known. To these quantities were added the quantities moved since construction, in widening banks, reducing grades, taking out sags, filling bridges and widening and deepening cuts. The result being the actual quantities as nearly as possible to arrive at same, required to make the roadbed as it exists today."

It will be noted that Mr. Hogeland's estimate gives an average of 33,250 cu. yds. of excavation per mile of main track, distributed thus:

Earth	75.0%
Hardpan	15.4%
Loose rock	3.8%
Solid rock	5.8%
Total	100.0%

Mr. Hogeland testified that the part of the G. N. east of Havre (4,553 miles of main line) averaged 27,760 cu. yds. per mile, whereas the line west of Havre (2,082 miles of main line) averaged 45,250.

Mr. Hogeland gave the percentages as follows:

	East of Havre.	West of Havre.
Earth	88.4%	57.0%
Hardpan	10.2	22.4
Loose rock	1.1	7.4
Solid rock	0.3	13.2
Total	100.0%	100.0%

Mr. Gillette testified that Mr. Hogeland's estimate of yardage per mile was much too high, and cited actual records of the G. N. in the state of Washington where much of the heaviest grading on the G. N. is found. But, as we shall publish in detail Mr. Gillette's quantities and estimates of cost of each of the railway systems in the state of Washington, the reader may make comparisons for himself.

Mr. Hogeland arrived at his unit prices as follows:

Clearing:	Per Acre.
Contract price	$75.00
Transporting men, tools and supplies	7.50
	$82.50

Grubbing:	Per Sq. Rod.
Contract price	$1.50
Transporting men, etc	0.15
	$1.65

Earth:	Per Cu. Yd.
Contract price up to 1,000 ft. haul	$0.23
Overhaul	0.035
Transporting men, etc	0.045
	$0.31

Hardpan:	Per Cu. Yd.
Contract price up to 1,000 ft.	$0.35
Overhaul	0.045
Transporting men, etc	0.055
	$0.45

Loose rock:	Per Cu. Yd.
Contract price up to 1,000 ft.	$0.45
Overhaul	0.045
Transporting men, etc	0.055
	$0.55

Solid rock	Per Cu. Yd.
Contract price up to 1,000 ft.	$1.00
Overhaul	0.045
Transporting men, etc	0.055
	$1.10

Riprap:	Per Cu. Yd.
Contract price	$1.50
Overhaul or train service	0.35
Transporting men, etc	0.15
	$2.00

Retaining wall:	Per Cu. Yd.
Contract price (concrete or rubble)	$7.50
Train service	0.80
Transporting men, etc	0.70
	$9.00

Slope wall:	Per Cu. Yd.
Contract price	$2.50
Train service	0.75
Transporting men, etc	0.25
	$3.50

It is interesting to note in this connection that the actual yardage of excavation on about 700 miles of the G. N. in the state of Washington was 26,000 cu. yds. per mile for the original construction in the early '90's, and that the item of "overhaul" actually averaged less than ½ ct. per cu. yd. for every yard of material excavated, as compared with the 4½ cts. estimated by Mr. Hogeland. The free haul limit was 1,000 ft. Much the same criticism also applies to Mr. Hogeland's estimate of the cost of transporting men and supplies to and from the site of the work.

Mr. Hogeland's estimate of tunnels was as follows:

5,232 lin. ft. unlined sgl. track tunnel at $70	$ 366,240
17,346 lin. ft. timber lined sgl track tunnel at $120	2,081,520
6,139 lin. ft. concrete lined sgl. track tunnel (Boulder) at $175	1,074,325
13,813 lin. ft. concrete lined sgl. track tunnel (Cascade) at $195	2,693,535
5,141 lin. ft. concrete lined dbl. track tunnel at Seattle, $1,848,000, two-thirds to G. N.	1,232,000
Total	$7,447,620

The unit prices were arrived at as follows:

Unlined tunnel:	Per Lin. Ft.
Contract price for standard unlined section	$55
Extra excavation	8
Transporting men, tools, supplies, etc	7
	$70

Timber lined tunnel:	Per Lin Ft.
Contract price for standard unlined section	$55
Enlargement for timber lining	30
Timber and iron in place	25
Transporting men, etc	10
	$120

Concrete lined tunnels:

(Boulder Tunnel.)

	Per Lin. Ft.
Excavation	$ 90
Temporary timber lining	20
Permanent masonry lining	45
Transporting men, etc	20
	$175

(Cascade Tunnel.)

	Per Lin. Ft.
Excavation	$ 95
Temporary timber lining	25
Permanent concrete lining	50
Transporting men, etc	25
	$195

Bridges, trestles and culverts:

1 stone arch (Minneapolis), 1,770 lin. ft.	$ 867,000
260 steel bridges with masonry piers, 63,557 lin. ft.	6,941,645
3,934 timber trestles, 429,851 lin. ft.	5,216,480
189 Howe truss spans, 19,996 lin. ft.	905,478
4,940 permanent culverts	3,021,685
4,021 timber culverts	1,000,740
Total	$17,953,028

Mr. Hogeland did not give the number of pounds of steel, yardage of masonry, etc. He stated, however, that he used the following unit prices, to which he subsequently added ½ ct. per ton per mile for transporting the materials, so that these unit prices do not include the cost of transporting the materials:

Steel in bridges:	Per Ton.
Contract price ready to erect, f. o. b. St. Paul	$65.00
Mill and shop inspection	.75
Erection	12.00
Painting	2.25
	$80.00

This is equivalent to 4 cts. per lb. erected, exclusive of the cost of transportation from St. Paul.

Masonry:	Per Cu. Yd.
First class	$12
Second class	8
Concrete	6

Excavation, coffer dams, pumping, etc., variable.

Timber trestles:

Timber in place, per M	$31.50
Piling in place, per ft.	0.35
Wrought iron, per lb.	0.05

Freight to be added.

Howe truss spans:	Per Lin. Ft.
44 ft.	$18.50
60 ft.	27.00
75 ft.	34.00
87½ ft.	35.50
100 ft.	37.50
125 ft.	42.00
150 ft.	45.00

Freight to be added.

Howe truss timber, per M	$25.00
Rods, plates, etc.	0.03
Bolts	0.025

Freight to be added.

Vitrified pipe culverts:	Per Lin Ft.
12-in. pipe	$0.25
18-in. pipe	0.50
24-in. pipe	1.15
27-in. pipe	1.52

Freight to be added.

Cast iron pipe culverts, $30 per net ton, plus freight.

Mr. Hogeland estimated 2,850 ties per mile of main track and 2,750 per mile of side track, at the following cost:

Delivered on right of way	$0.48
Train service and loading and handling	0.09
Burnettizing ¼ of all ties at 16 cts.	0.04
Transporting 500 mi. at ½ ct. ton mile	0.21
Total	$0.82

He estimated 8,880 sets of switch ties as follows per set:

F. o. b. mill, per M	$60
Transporting 500 miles, per M	15
	$75

The rails for the main track averaged 68.1 lbs. per yd. and for the side track 60 lbs. Five rails per mile were added for "repair rails." The cost of rails was estimated to be:

	Per Gross Ton.
F. o. b. St. Paul, including handling	$32
Transp. 800 miles at ½ ct. ton mile	4
	$36

Angle bars were estimated at 17,600 lbs. per mile of side track at a cost of:

	Per Net Ton.
F. o. b. St. Paul	$40
Transporting 800 miles	4
	$44

Bolts and nuts were estimated at 1,800 lbs. per mile of main track and 1,500 lbs. per mile of side track, at a cost of:

	Per Net Ton.
F. o. b. St. Paul	$54
Transporting 800 miles	4
	$58

Spikes were estimated at 6,500 lbs. per mile of track, at a cost of:

	Per Net Ton.
F. o. b. St. Paul	$42
Transporting 800 miles	4
	$46

Tie plates were estimated at 29,000 lbs. per mile of track where fully tie plated (or 5 lbs. per tie plate), and it was assumed that 2,451 miles were fully tie plated and 1,950 miles half tie plated, at a cost of:

	Per Net Ton.
F. o. b. St. Paul	$45
Transporting 800 miles	4
	$49

It was assumed that 750 miles of track were provided with rail braces at 2,000 braces per mile, at a cost of 10 cts. per brace.

Summary of track fastenings:	
Angle bars	$3,090,736
Bolts and nuts	431,288
Spikes	1,304,284
Tie plates	2,399,187
Rail braces	150,000
	$7,375,495

Mr. Gillette testified that these items were substantially correct except as to the number of tie plates, which was very much overestimated.

Frogs and switches:	
Complete turnout, f. o. b. St. Paul (3,750 lbs.)	$85.00
Transp. 800 mi. at ½ ct. ton mile	7.50
	$92.50

8,880 turnouts (except ties) at $92.50	$821,400
302 crossing frogs at $275	83,050
	$904,450

The "complete turnout" includes switch stand and bolts, lamp, switch points, connecting and tie rods, plates, rail braces, clips, frog and guard rail, but does not include cross ties.

Mr. Hogeland estimated that 3,750 miles of the main track averaged 3,000 cu. yds. of gravel ballast per mile, and that 1,900 miles averaged 2,250 cu. yds. per mile. Of the 1,480 miles of side track, he estimated that 950 miles were ballasted with 1,500 cu. yds. per mile. This made a grand total of 16,950,000 cu. yds. of ballast on the system, the cost of which was estimated as follows:

	Per Cu. Yd.
Loading, unloading, putting under track and dressing track	$0.27
Maintenance and repairs of steam shovels	0.05
Train service, hauling, repairs and rental of equipment, transp. of men, tools and supplies	0.30
	$0.62

Mr. Gillette testified that this estimate of unit cost was fully 50 per cent more than the actual cost as shown by the records of the G. N. and that gravel ballast could be placed for less than 40 cts. per cu. yd. under existing conditions.

Mr. Hogeland estimated the cost of track laying and surfacing as follows:

	Per Mile.
Curving rails, laying and surfacing	$350
Labor of tie plating (average)	45
Train service and rental of equipment and hauling to front	390
Transporting men, supplies, etc.	50
	$835

8,115.58 miles at $835	$6,776,409
8,880 switches placed at $25	220,000
	$6,998,409

Mr. Gillette testified that the item of train service was about three times higher than the actual cost, and that the transportation of men, etc., was even more excessive.

Mr. Hogeland estimated 4,611 miles of right of way fences at the following cost per mile:

	Per Mile.
Standard fence	$150
Train service distributing materials	10
Transporting men, etc.	5
	$165

He estimated the cost of crossings, cattle guards and signs as follows:

6,635.34 miles at $75 for cattle guards, signs, etc.	$ 497,650
58 steel highway bridges (overhead)	1,344,000
Timber bridges (overhead)	80,510
	$1,922,160

Interlocking or signal apparatus:	
Interlocking	$327,750
Block signaling	58,440
	$386,190

Telegraph lines:	
Labor	$ 650,614.48
Material	1,295,207.46
Train service	16,638.00
Transp. men, tools, matl., etc.	219,598.22
Quadruplex instruments, batteries, furniture, etc., in 8 main offices	16,225.00
Total	$2,198,283.16

This is equivalent to the following cost per mile of telegraph line:

	Per Mile.
Labor	$ 98.00
Material	200.00
Train service	2.50
Transporting men, etc.	33.00
Quadruplex instruments, etc.	2.50
Total	$336.00

Mr. Gillette testified that this was an excessive estimate, and that, so far as the state of Washington was concerned, the G. N. did not own a large part of the telegraph lines and that, in fact, it was the common practice for railways to share the ownership of the lines with telegraph companies, as shown by the accounting records of the railways.

Passenger depots:

Seattle (one-half interest)	$ 295,000
Spokane	137,500
Grand Forks	37,500
Fargo	41,800
Sioux City	180,000
Minneapolis union depot	342,500
29 other passenger depots of brick or stone	419,600
705 frame passenger and freight depots	1,226,700
14 freight depots of brick or stone	422,900
Frame freight houses	172,800
Total	$3,276,300

The St. Paul union depot (of which the G. N. owns one-ninth interest) and the Superior depot (of which the G. N. owns one-third interest) are not included above, but are included under "right of way and station grounds." Mr. Hogeland did not give any dimensions of buildings, so that it is impracticable to check his estimates.

Shops, roundhouses and turntables:

Shop, St. Paul	$ 854,400
Shop, St. Cloud	75,400
Shop, Superior	91,000
Shop, Barnesville	17,500
Shop, Sioux City	12,500
Shop, Devils Lake	60,000
Shop, Havre	91,000
Shop, Great Falls	42,000
Shop, Spokane	124,800
Shop, Everett	70,200
Roundhouses, frame, 88 stalls, at $1,400	123,200
Roundhouses, masonry, 554 stalls, at $2,100	1,163,400
Boiler houses, power houses and small shops	216,000
Turntables, frame, 10, at $1,800	18,000
Turntables, steel, 57, at $6,500	370,500
Cinder pits	140,000
Store houses, oil and sand houses and scrap bins	198,000
Total	$3,657,900

Water stations:

420 water stations (at $4,722)	$1,983,325

This includes tanks, pump houses, pumps, engines, wells, reservoirs and all appurtenances of water stations. It will be noted that this supplies one station every 16 miles of road.

Fuel stations:

52 standard coaling stations at $9,500	$544,500
52 platforms coaling stations, portion with cranes and buckets, $600	31,200
Total	$575,700

Grain elevators:

Minneapolis	$ 240,000
Superior, A and X	823,100
Superior S (steel)	1,536,400
Seattle, Smith's Cove	108,600
Total	$2,708,100

Storage warehouses:

Superior, flour shed	$142,800
Five wool houses	19,800
Seattle, warehouse, Smith's Cove	113,900
	$270,500

Docks and wharves (including dredging):

Superior No. 1	$ 175,000
Superior No. 2	80,800
Superior Nos. 5 and 6 and mchy.	449,500
Seattle, Smith's Cove dock	517,600
Total	$1,222,900

Miscellaneous structures:

General office building, St. Paul	$ 590,000
Division office buildings	18,000
Boarding houses	87,500
Section houses, bunk houses, hand car houses	853,500
Ice houses	107,500
Stock yards	157,600
Track scales	92,250
Snow sheds	295,000
Snow fences	450,000
Loading platforms	71,000
Quarry and crusher plants	45,000
Tie treating plant	85,000
Commissary buildings	15,000
Miscellaneous buildings	327,500
Total	$3,194,850

Mr. Hogeland allowed 10 per cent of items 3, 4, 5, 10, 11, 16, 17, 19, 20, 21, 22, 23 and 25 for "contingencies," to cover the increased cost of the work due to unforeseen causes, such as fires, floods, tornadoes, accidents, etc. Mr. Gillette testified that, while an allowance for "contingencies" is certainly permissable in estimating the cost of *projected* work, it is not permissable in estimating the cost of *completed* work, particularly where the actual costs are on record for nearly all the work, as is the case on the G. N.

In estimating the interest charges during construction Mr. Hogeland assumed that the system, including equipment, would be unproductive for a period of two years. He assumed that it would take eight years to reproduce the system, 1,000 miles of track (main and side) being built per year, and that it would be two years after the beginning of the work before the first 1,000 miles would produce sufficient revenue to pay interest on the investment, and so on with the rest. Hence, two years at 5% is 10% of the total cost to be charged for interest.

It will be interesting to compare this estimate with the actual interest charges as taken from the ledgers of the different railway companies operating in the state of Washington. These data will be published in this journal in the near future, along with the other items of actual cost as ascertained by Mr. Gillette for the Railroad Commission of Washington.

For purposes of comparison with the estimated cost of the N. P. (published in our April 15 issue) we append the estimated cost of the G. N., by items per mile of main and second track, as determined by dividing Mr. Hogeland's items by 6,635.34:

The mileage of the Great Northern under operation April 1, 1907, was:

6,635.34 miles main and second tracks.
1,480.24 miles side tracks.

8,115.58 miles total tracks.

There are 112.25 miles of second track included in the above, and it will be seen that there is 0.22 mile of side track per mile of main and second track.

	Cost of reproduction per mile of main and second track. (6,635.34 miles.)
Engineering	$ 1,035
Right of way and station grounds	13,160
Grading	14,030
Tunnels	1,070
Bridges, trestles and culverts	2,705
Ties	2,820
Rails	4,680
Track fastenings	1,110
Frogs and switches	135
Ballast	1,585
Track laying and surfacing	1,055
Fencing right of way	115
Crossings, cattle guards and signs	290
Interlocking and signal apparatus	60
Telegraph lines	330
Station buildings and fixtures	495
Shops, roundhouses and turntables	550
Shop machinery and tools	270
Water stations	300
Fuel stations	90
Grain elevators	420
Storage warehouses	40
Docks and wharves	185
Gas making plants	2
Miscellaneous structures	480
Track and bridge tools	20
Stores and supplies on hand	815
Contingencies	2,300
Equipment	6,170
General and legal expense	563
Interest	5,690
Grand total	$62,570
Deduct right of way and station grounds	13,160
Cost, exclusive of right of way and station grounds	$49,410
Deduct equipment	6,170
Cost, exclusive of lands and equipment	$43,240

Plans have been completed for the erection of three new coke plants by the H. C. Frick Co., in the Connellsville region. They will cost $4,000,000.

The average cost of all sweeping and cleaning of asphalt, asphalt block or brick streets at Rochester, N. Y., in 1906, was $557.87 per mile, or $32.175 per thousand square yards. The average width of street is 28 ft.

Structural Steel Section

Note: This section is devoted to methods and costs of constructing steel structures. It will cover tests of steel, shop work and erection, giving particular attention to erection plant, methods and costs for building and bridge construction.

Methods of Erecting a Steel Arch Bridge

The following is abstracted from a paper by L. D. Rights entitled the Erection of the Bellows Falls Arch Bridge in the Proc. Am. Soc. C. E., Vol. XXXIV, page 202, presented before the society on April 1, 1908. The bridge was erected between the two towns of North Walpole, N. H., and Bellows Falls, Vt., being paid for by the two towns.

As will be seen, the bridge is about 650 ft. long, and consists of a single, three-hinged, arch span, 540 ft. from c. to c. of end pins, with a short truss span at the west end, 104 ft. 8 in. from center to center of bearings. This short span was necessary, in order to carry the street over the Rutland railroad. It will be noted that the roadway is on a grade of 3.33 per cent, running downward from the short span to the abutment at the east end. The height of the main arch is 90 ft. between the hinge centers. The truss chords follow the lines of two parabolas 14 ft. apart. In order to secure simplicity of detail, the trusses do not diverge at the bottom, but stand in parallel vertical planes, 30 ft. from center to center. This provides for a roadway, 20 ft. clear, and one sidewalk, 6 ft. wide. At the east end of the arch an abutment has been provided, and at the west end two piers take the thrust of the main arches, and support the vertical posts which carry the end of a small truss bridge.

The floor is designed for either a live load of 100 lbs. per sq. ft. or a 12-ton wagon load on two axles, 10 ft. from center to center. In addition, provision is made in the hangers and floor beams for a single-track line of 18-ton electric cars, to run on the opposite side of the bridge from the walk. The connections for track stringers have been provided in the floor beams, and, if it should be thought advisable in the future to carry the trolley line over to the New Hampshire side, it can be done at a very small expense.

The main trusses are designed for a live load of 60 lbs. and for a wind load of 40 lbs. per sq. ft. The floor is suspended from the arches by two hanger bars, 1¼ in. square at each panel point. These are connected, with 2-in. pins, to the truss at the top and the floor beams at the bottom. The hangers can only take the vertical load, and therefore wind chords have been provided in the planes of the trusses at the level of the roadway. These chords, with the floor laterals, form a horizontal truss which carries the wind stresses to the abutments. To prevent complication in the arch stresses, this lateral system is not attached to the arches rigidly, but has expansion joints at each end transmitting shear only.

The steel was furnished in accordance with the specifications of the American Railway Engineering and Maintenance of Way Association, with an ultimate tensile strength of 60,000 lbs. per sq. in. The flooring timber is long-leaf Georgia yellow pine of prime quality.

One of the unique features of the design is the arrangement which was adopted for the middle of the arch. It will be noticed that, instead of converging the chords at the center panels, in order to take the stress of the center hinge, he has taken the horizontal thrust on a short strut, composed of two 15-in. channels, and has then divided this thrust into four parts at the intersection of the diagonals in the panels next to the center. In this way he has secured the architectural features of a two-hinged arch with continuous chords, adding considerably to the appearance of the bridge. It will also be noticed that he has dispensed with the pin at the center, the struts merely bearing against one another with faced ends.

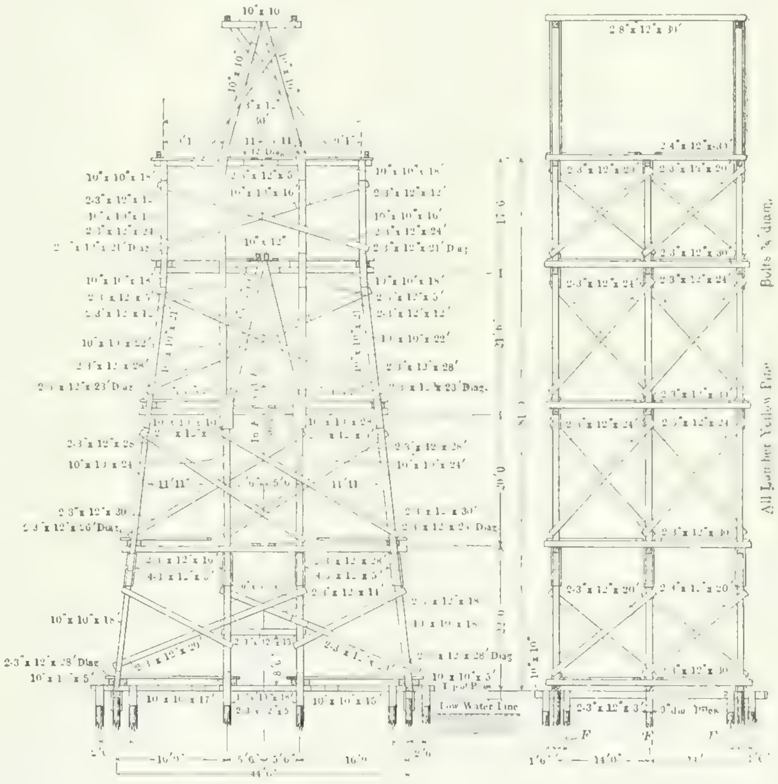


Fig. 1—Details of Falsework Towers, Bellows Falls Arch Bridge.

In order to avoid the optical illusion of a sag in the suspended floor, this was cambered 18 in. at the center of the arch. It was felt that this camber would take care of any slight deflection due to live load, and the design and details of the arch were developed on theoretical lines, with no provision in the arch for either live or dead-load camber.

Erection Design.—In securing data for the preliminary design for the estimate of the cost of erection, the idea of building towers some distance apart and erecting the trusses by the cantilever method, suggested itself to the writer, the main question being to determine the economic spacing of these towers. As it was not considered advisable to do any riveting until the arch was swung, it was necessary to plan to bolt all connections temporarily. The strength of these bolted connections, therefore, was a factor in the length of the cantilever. Another consideration was the distance that material could be hauled satisfactorily with a standard 60-ft. steel boom. The writer made a design, and decided that a span of six panels, or about 80 ft., would give the best results. The sizes and details were then developed in the drawing room, under the direction of the chief engineer.

On account of the narrow width of the structure in comparison with its height, the center falsework towers were battered in the plane at right angles to the bridge, thus enabling them to withstand better the shock of winter storms or floating ice. The general elevation of the falsework towers is shown in Fig. 2, which indicates the numbering and spacing of the pile supports. The details of the center bents *F* F_1, and F_2, are shown by Fig. 1, which gives the size of the main posts and bracing, and indicates the splices and number of bolts.

It was considered advisable, on account of the switching facilities, to unload the material on the Vermont side of the bridge and carry those pieces required for the east side on a standard gauge service track running between the towers, along the center line of the bridge. A 10-ton stiff-leg derrick was placed on the west shore, to unload material from the cars and transfer it to the trucks on the service track. Two 30-h. p. hoisting engines, with two drums and four spools each, were located at Bent *E* to raise the steel.

Erection.—The masonry plans provided for piles to be driven in the foundations for the arch, and, as the masonry contractor was well equipped to do the work, the contract for furnishing and driving the piles for the falsework was sublet to him. The water has an average depth of about 25 ft., and the bottom is hard gravel. Spruce piles were specified, in order that they might be sold to the pulp mills after the work was completed. They were driven from 8 to 10 ft. into the bottom, and were cut off and capped about 3 ft. above the low-water line. The falsework towers were completed in November, and the shoes were set on December 6, 1904.

Two gangs were started, one from each end of the arch, and the rivalry between them helped not a little in the rapid erection of the work. The severe weather of the winter of 1904-05 will no doubt be remembered, but, even in that latitude, there were breaks in the cold, and on two separate days considerable rain fell. The fear that the ice might go out, which would mean taking out the falsework and everything with it, was a constant incentive to hasten the erection in every way possible. It had not been the intention to do any work on the ice, but after it had frozen to the thickness of about 2 ft., it was found to be very convenient when assembling the chords, which were handled in two sections of four panels each. The ice also acted as a hindrance, for when the canal gates were closed, on Sundays and holidays, the river rose about 18 in., and it was necessary to keep the ice chopped free from the piles.

When the ice first began to form about the falsework, the structure showed a tendency to move down stream. This was carefully noted, account of it being taken in placing the steel. When the arch was swung, some of the bents were found to have moved down stream about 4 in. As the load was put on the falsework, some of the bents sank slightly, but this settlement was adjusted with wedges under the blocking at each point of support.

The two end panels of the lower chord and the end panel of the upper chord were

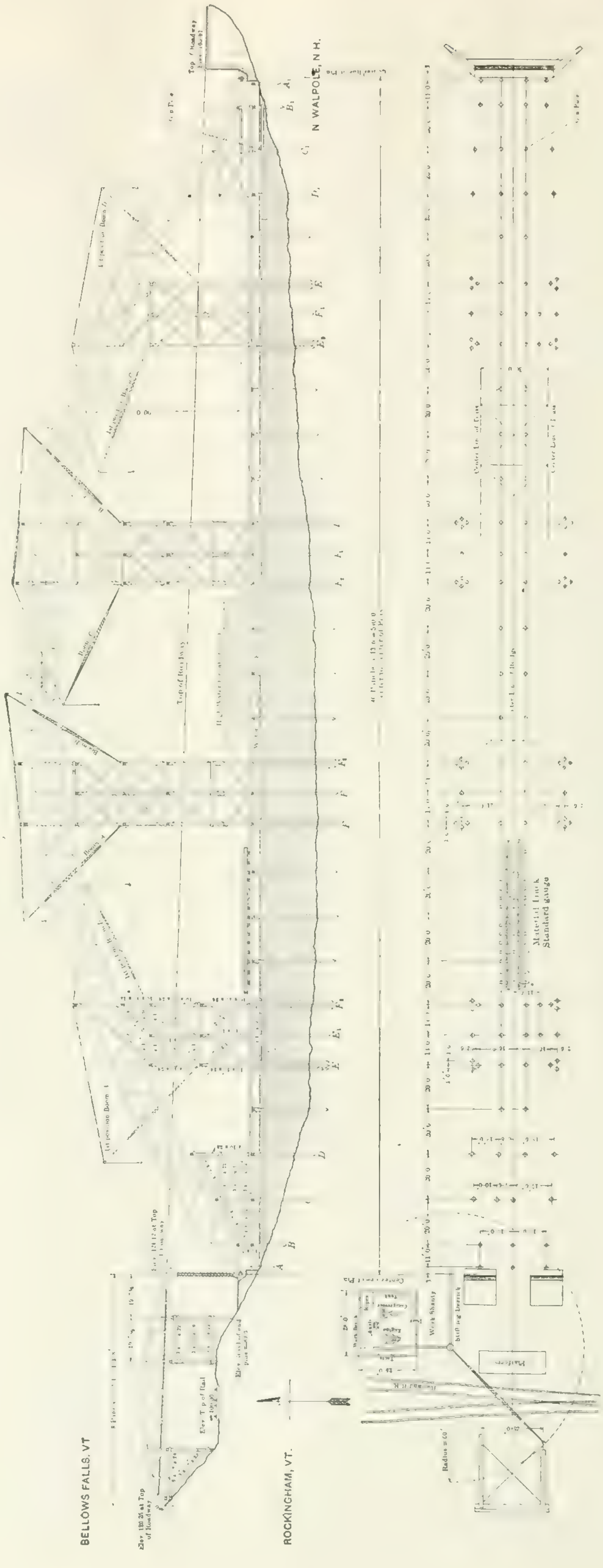


Fig. 2—Falsework of Bellows Falls Steel Arch Bridge.

shipped riveted together. These members each weighing about 8 tons, constituted the heaviest pieces to be handled.

In beginning the erection, the shoes and end panels of the west end were set with the stiff-leg derrick used for handling material from the siding to the material trucks. On the east end a gin pole was placed to set the shoes and end panels. Provision had been made in the plans for a clearance of 4 in. behind the steel shoes. As soon as the shoes and the first panels had been set and lined up, this space was filled with concrete.

Two standard steel booms, *A* and *D*, of 10 tons capacity, were erected at Bents *E*, and with these the steelwork was erected so as to rest on top of the falsework at these bents. Booms *B* and *C* were then erected at Bents E_2, and, with the assistance of the first two booms, the structure was laid across the *E* towers. Booms *A* and *D* were then taken down and re-erected at Bents *F*, thus giving two booms to handle the material over the 80-ft. space between Bents E_2 and *F*. The lower chords for two sections of four panels were assembled on the ice, with the first diagonal at Bent E_2 attached to them. Then, while Booms *A* and *D* held up the material, Booms *B* and *C* were used to fill in the web members and put on the top chord. The last section of bottom chord from the cantilevered end of Bent *F* was placed by Booms *A* and *D*, which filled in the web members and the top chord. While this was being done, Booms *B* and *C* were taken down from their first position and re-erected at Bents F_2. The steelwork was carried across the *F* towers, and the erection of the 80-ft. span between them was taken care of by these two booms.

To overcome the natural tendency of the chords to lengthen during erection, and to adjust any slight errors in the measurement between the end-pin centers, the details at the center were arranged to allow a slight leeway at the meeting points. The chords and the vertical posts at the center were set back 2 in. on each half from the center line, making a total clearance between them of 4 in. The center strut projected a little beyond the vertical posts, but was set back 1½ in. from the center line on each half, making a total clearance of 3 in. between the bearing points. With the intention of being able to take up the theoretical opening of 3 in. and for any adjustment that it might be necessary to make, 6 in. of fillers were provided. When the trusses reached the *F* tower, it was found that the erector had failed to make sufficient provision for the settling of the falsework at Bents *D* and *E*. The result was that the arch was low, and measurements showed that the steelwork would overlap at the center. The trusses were raised to their proper height by wedges at the tops of all the towers. When the steel work was joined at the center, it was found that it had slightly over-run the calculated distance. Instead of 3 in. of fillers, theoretically needed, a thickness of only 1½ in. was required.

As soon as the work was connected up it was thoroughly bolted. The web members were fastened with bolts in 75 per cent of the holes, and the chords with bolts in 50 per cent of the holes. When this was done, the wedges were knocked out and the arch ribs were swung off. As the only load the arch ribs had to support was that of the steel in the trusses, the deflection at the time of swinging off was comparatively small. The erection superintendent reported that the settlement at the crown was about 1½ in.

The trusses were connected and swung off on January 10, 1905, making a total of 35 days from the time of setting the shoes until the arches were swung off. From this time should be deducted one holiday three Sundays, and three days of cold or wet weather, which gave an actual working period of 28 days. During a good portion of this time the thermometer was about at zero, which made it difficult for the men to work actively.

The falsework was taken down the day after the arches were swung off, and the erection gang started from both sides to put in the hanger rods and place the steelwork of the floor system. The wood floor was not put on at this time, so that no local deformation of the arch ribs was noticed. While the steel floor system was being placed, other gangs adjusted the bracing and lined up the arches. It had been the intention to do the field riveting with pneumatic riveters, but a day before the riveting was to begin, the tool-house was destroyed by fire, and the compressor was injured so that it could not be used for this work. Eight gangs, of four men each, drove the field rivets by hand. As soon as the weather would allow, the field painting was completed and the wood floor laid.

Thirty-six men were employed when the erection of the steelwork began, and the number was increased afterward to forty-five. The weight of the structural steel was 450 tons for the main arch span, and 75,000 ft., B. M., of lumber were used in the floor. The contract price for the masonry was $6,000, and for the superstructure $41,000.

The decrease in shipbuilding in the United Kingdom is said to be the greatest in a quarter of a century. The tonnage now under construction is 101,000 less than at the end of last quarter, and 459,000 less than that of twelve months ago.

Since actual construction work was begun 1½ years ago, the Sewerage Commission of Baltimore, Md., has completed 22 miles of sanitary sewers and storm water drains. The total cost of the sanitary sewer work to date is $999,316.

Steel Bridge Dams with Boule Gates New York Barge Canal.

In that portion of the New York Barge canal work involving the canalization of the lower Mohawk river movable dams of great extent are required. The original plans called for fixed dams.

In point of cost the movable system compares favorably with the original plans, which provided for eight fixed dams with a total length of about 9,300 ft. and an estimated cost of about $1,880,000. The eight movable dams adopted will have a total length of about 3,650 ft. and the preliminary estimated cost was about $1,825,000, showing a balance in their favor of $54,000. In point of fact a considerably larger saving in first cost resulted than at first appeared, because the original estimate of 1900 was based on prices of material, etc., which have since largely increased, while the actual contracts for the movable dams were made from 2 to 5 per cent below their preliminary estimated cost. A large saving in channel excavation was also secured.

In appearance these dams on the Mohawk (some of which are now being built and all are under contract) will seem to be bridges with abutments and piers, but of somewhat heavier construction than usual. From the down-stream side will hang a series of steel frames, 15 ft. apart and hinged at the top, extending to a concrete sill stretching between abutment and pier across the width of the river. Each frame will carry an upper and a lower tier of gates, which are large rectangular steel plates and may be raised or lowered, rolling on a track on the frame and moving somewhat like an ordinary window sash. When serving as a dam the bottoms of the lower gates will all be lowered so as to rest on the foundation in the bed of the stream, the tops of the upper gates forming the crest of the dam and regulating the elevation of the water surface at ordinary stages. When it is desired to let more water escape than will spill over the crest, the gates are partly raised, one or all, and the water rushes through the orifice thus opened. For convenience in regulating the stream, the gates are divided horizontally into two tiers, which may be raised successively. In time of extreme flood or during the winter season, the frames and gates may both be removed from the stream, leaving an unobstructed channel, simply spanned by a bridge. To accomplish this the frames are attached to the bridge at their tops by a hinge-like joint so that they may be swung up under the bridge floor to a horizontal position, carrying the gates with them.

A maximum depth on the masonry sills was adopted of 20 ft., and a minimum of 16 ft., and the lifts range from 8 to 15 ft. These figures are interesting in comparison with the size of the first movable dam constructed in 1834, where the lift was a little over 3 ft., and the depth on sill about 6 ft.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Method and Cost of Lock and Dam Construction by the U. S. Government on the Upper White River, Arkansas.

White River rises in the Ozark Mountains in the extreme northwestern part of Arkansas, and its total length from its source to its junction with the Mississippi River is 690 miles. At Jacksonport, Ark., six miles above Newport, Black River, a tributary stream, joins White River. That portion of White River above this point is usually referred to as Upper White River and is in general a mountain stream.

The rainfall in the Upper White River valley is stated to be 40½ ins.; 7½ ins. have been known to fall on the headwaters in 12 hours. The approximate drainage area of White River to a point about 27 miles above its junction with Black River, is 10,900 square miles. The ordinary average low-water flow of the Upper White River is about 1,500 cu. ft. per second.

Between Batesville and Buffalo Shoals, 89 miles, the ordinary low-water width averages about 600 ft., varying considerably, in some cases not exceeding 175 to 200 ft., while in the pools it is 700 to 800 ft. From the mouth of the river to its junction with Black River, 264 miles, the channel is seldom less than 3 ft. deep. Between Black River and Batesville, 38 miles, the average depth over the shoals during ordinary low water, is 18 to 20 ins. Above Batesville the common depth over the flat gravel shoals is 10 ins. The first attempt to improve Upper White River was made in 1879, when the improvement of Buffalo Shoals by means of wing dams was undertaken. From this point work was extended a short way up the river to Summers Shoal and down the river to the mouth of Black River, contraction works at 36 different shoals in the 141 miles of river between these points being built. The project for open river improvement contemplated obtaining a 2-ft. channel depth at low water, but this depth was not obtained except in a few isolated cases. Several types of wing dams were tried. The first ones at Buffalo Shoals were rubble mounds covered with a layer of comparatively regular stones laid compactly by hand. Other wing dams were constructed of gravel and stone and brush in alternate layers. Below Batesville the type used was a 2-row pile dike with brush wattling. In the final work of 1896 a stone and pile dike was used, the piles being driven in a single row and a waling piece placed at the crest height of the dam; rubble stone was then heaped up to that height, the top width of the heap being 4 ft. on the upstream side. The upstream slope was 1 on 2 and the downstream slope 1 on 1. When the wing dams were built on gravel a mattress was used as a foundation. The width of the mattress was never less than 40 ft., and it was so placed as to provide an apron 8 ft. or more wide to catch the overfall over the wing dam. As to service, the paved rubble dams at Buffalo Shoals were the best and stood well; the pile and stone dikes of 1896 were the next best, while the gravel and brush dikes were the poorest. These works were not successful, many of the shoals not having more than 10 or 12 ins. of water over them during low water. As a result, operations were confined to maintaining the works already built, and eventually a project for the canalization of the river was adopted.

The present project provides for slackwater navigation, giving 4 ft. depth from Batesville to Buffalo Shoals, a distance of 89 miles, by means of ten fixed timber crib dams, with concrete locks, having an average lift of 14½ ft. The total estimated cost of the work was $1,600,000. The construction of the first dam and lock in the project are described in this article, the descriptive matter being obtained from the report of Maj. Graham D. Fitch, Corps of Engineers, as given in an annual Report of the War Department for 1904. The cost data were collected by Major Fitch and we are indebted to him for leave to publish them here. In the costs to be given the item labor includes field supervision and subsistence cost; the item material covers cost of material as per certified bills. The cost of the material delivered at the work was $3,389.37 greater than shown in the grand total. This amount, however, is included in the labor as it covers inspection and transportation of material from railroad yards to lock yards. Subsistence includes cost of provisions, fuel and pay of cooks and helpers. The wages paid were as follows: Foreman and engineman from $50 to $90 per month and subsistence; laborers received $1.20 with or $1.50 without subsistence, for an 8-hour day. A few laborers were employed by the month at from $30 to $40 per month with subsistence.

LOCK NO. 1.

Lock and dam No. 1 were located about one mile below Batesville, Ark. The point chosen was on a bend of the river where it was less than the average width, and was flanked in the bottoms near the hills by high water cutoffs or swales subject to overflow as soon as the water should reach a height 5 ft. above the crest of the dam. The lock was built on the concave side of the river bend, owing to the fact that the rock was nearer the surface.

The lock was of concrete masonry, 175 ft. long, between hollow quoins. The lock chamber was 36 ft. wide and the lift was 14 ft. The lower miter sill of the lock was placed 5 ft. below extreme low water. The depth of water on the upper miter sill was also 5 ft. The guard of the lock walls was 10 ft., this figure being adopted empirically to conform with practice on Green River.

Lock Foundations.—The lock was founded on sandstone bed rock, and as the foundation bed afforded no foothold for piles, crib cofferdams were used. These were built and sunk in sections from 20 to 30 ft. long, each section consisting of round oak logs 7 to 9 ins. in diameter, driftbolted together with ⅝-in. round iron. The walls were tied together every 10 ft. by a transverse crib wall. Above the water the cofferdam was a continuous crib. The inside faces of both walls were sheeted with boards driven to a good bearing with hand mauls, a single row of 1-in. boards being used for the outer wall and double lap 1-in. and 2-in. boards for the inner wall. The pens were filled with clay and the dam well banked on the outside. The puddle, which was taken from a bank nearby, was loaded by a dipper dredge on a barge and placed in the dam with shovels. The inside width of the cofferdam was 10 ft. 8 ins., and its length was 462 ft. It was built to a 9 ft. stage and had an average height of 17 ft. The dam was built in 6 weeks time and the pit was pumped out in about 11 hours with one 10-in. centrifugal pump. A 3½-in. pulsometer pump was used to keep seep water out of the pit. There was very little leakage except during rises, after which the dam always had to be repuddled, as much of the backing was washed away by the swift current. The cost of this cofferdam was as follows:

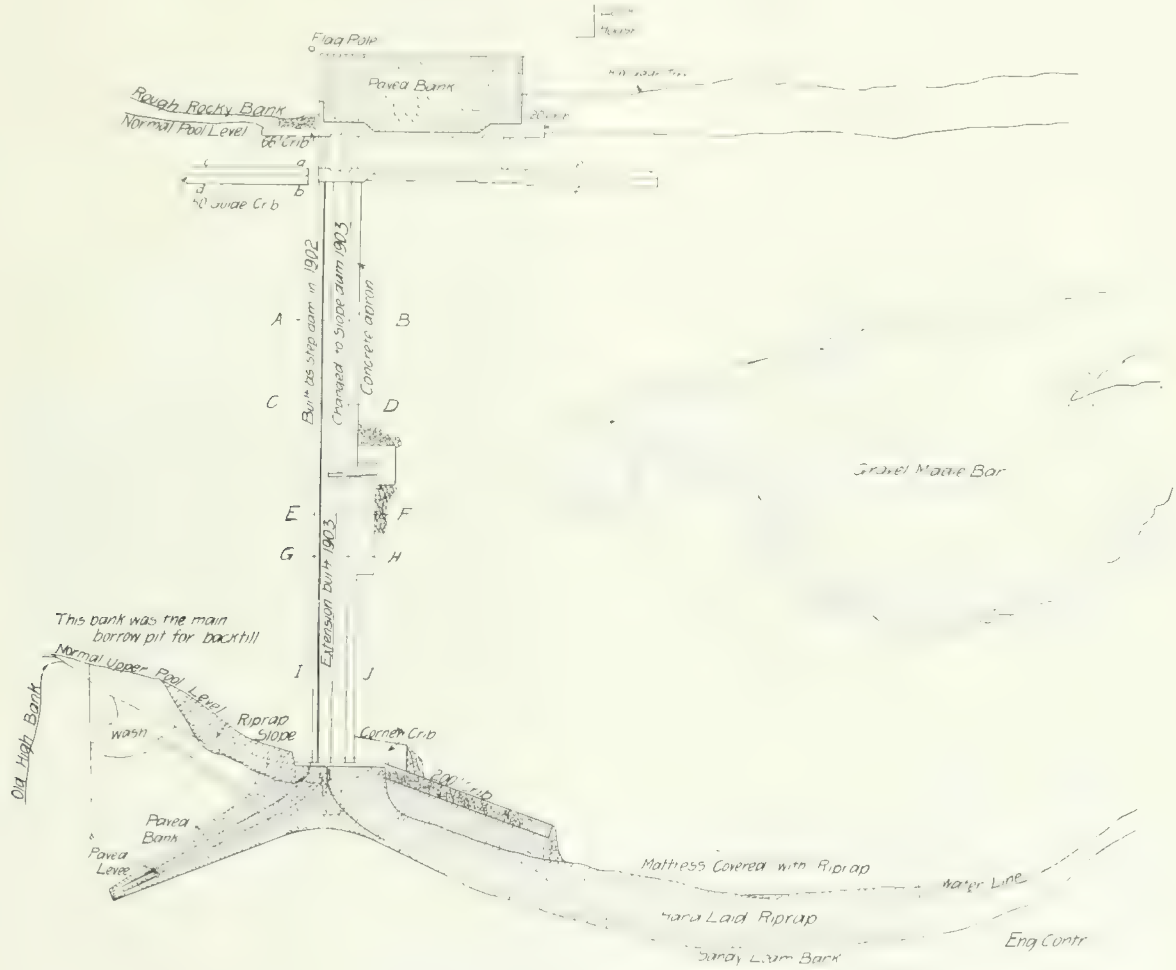
Cofferdam (462 lin. ft.)

Materials:	Unit Cost.	Total.	Per Lin. Ft. Cofferdam.
Logs, 30,560 lin. ft.	$ .0365	$1,115	$2.41
Timber, 32.8 M ft. B. M.	10.90	360	.78
Iron, 8,139 lbs.	.0289	234	.51
Straw, 12 loads	1.75	21	.04
Fuel		177	.38
Illumination, oils, etc.		104	.22
Total materials		$2,011	$4.34
Labor:			
Quarrying and placing breakwater stone, 498 cu. yds.	$0.718	$ 388	$ .85
Excavation, 300 cu. yds.	.562	169	.36
Hauling lumber, 20 M ft.	.86	17	.04
Placing logs, 30,560 lin. ft.	.02	638	1.38
Placing timber, 32.8 M. ft.	1.73	57	.12
Digging puddle, 7,860 cu. yds.	.062	490	1.06
Placing puddle, 7,860 cu. yds	.53	4,179	9.05
Pumping pit		539	1.17
Total		$6,476	$14.03
Grand total		$8,487	$18.37

Some of the labor items may be still further summarized as follows:

	Work Done.	Labor Time in Days.	Work Done Per Man Per Day.
Quarrying and placing breakwater stone ..	498 cu. yds.	248	2 cu. yds
Excavation .	300 cu. yds.	95 1/8	3.16 cu. yds.
Placing logs	30,560 lin. ft.	370 1/8	82.59 lin. ft.
Placing timber ..	32.8 M. ft.	37 4/8	.863 M. ft.
Placing puddle	7,860 cu. yds.	2,392 6/8	3,284 cu. yds.

The total labor time in constructing the 402 lin. ft. of cofferdam was 3,660⅛ days. The unit cost per linear foot of cofferdam was $18.37 and the work done per man per day was .125 lin. ft. About 90 lin. ft. of cofferdam was removed by dredge and men, at a cost of $161; the labor time being 86⅜ days. The unit cost was $1.794 per lin. ft.



General Plan, Showing Layout of Work as Finally Completed.

In excavating for the foundation of the lock a 1¼ cu. yd. Bucyrus dipper dredge removed from the pit, before the cofferdam was closed, such material as it could handle; but owing to the large boulders encountered most of the excavating was done by hand after the cofferdam had been pumped out, the material—clay, boulders, and cemented gravel—being removed by wheelbarrows and derrick skips. The lock-wall foundations averaged 6 ft. in depth below the lock floor, the maximum depth being 6 ft. 5 ins. Both the chamber and miter wall were founded on bed rock.

The cost of excavation work was as follows:

Excavation (3,635 cu. yds.).

Material—	Unit Cost.	Total.	Per cu.yd. Exc'v'n.
Dynamite, 600 lbs......	$0.14	$84	$0.023
Fuel	...	9	.002
Illuminating oils, etc...	...	119	.032
Total materials		$212	$0.057
Labor—			
Excavat'g, 3,635 cu.yds.	$1.49	$5,438	$1.49
Cleaning lock pit.......	...	108	.029
Total labor		$5,546	$1.519
Grand total		$5,758	$1.58

The total labor time in days for excavating was 3,138¼ days and the work done per man per day was 1.16 cu. yds.

Concrete Work.—As stated previously, the locks are of concrete masonry, 175 ft. long, between hollow quoins. The height of the lock walls is 15 ft. above the upper miter sill, 29 ft. above the lower sill and 30 ft. above the lock floor. Being founded on solid rock, each wall acts separately, and the design is that of a retaining wall. The land wall is slightly stronger than the river wall, but its top is narrow. Opposite the chamber it is stepped in the rear with one foot offsets every 3½ ft., while the river wall is battered. Both walls are 14½ ft. thick at the bottom. At the top the thickness of the river wall is 6 ft., and of the land wall is 4 ft. 9 ins. The ends of the lock walls are necessarily thicker than the sidewalls of the chamber, as they must not only support the pressure from the gates but also provide work room for the lock tenders. The thickness of the lock walls at the heels of the gates was accordingly made 16 ft. The walls are in conformity with the usual practice, without batter inside. The available length of the lock chamber is 147 ft. and the width is 36 ft. The length of the wall below the lower quoin is 25 ft. and above the upper quoin 37. The total length of the lock is 237 ft.

The hollow quoins are shaped directly in the concrete, a form being used as for any other special surface. The shape is that of an arc of the same radius as the heel of the gate, namely, 10 ins.; they are 110 degrees in length, with tangents at either end 6 ins. long. The gate recesses are 22 ft. long and 2 ft. deep. The miter walls are without batter. Part of the lower miter wall is prolonged downstream to the lower end of the lock, so as to protect the tail bay from being scoured out by the discharge from the culverts.

The upper coffer wall, the function of which is to support a simple movable dam across the head of the lock when the upper gates or valves need repairing, has its sill 1 ft. below the upper miter sill. In coffering the head bay this sill forms the lower support for the needles used, the top support being a trussed beam, the ends of which rest in slots in the main walls at such an elevation that the trussed beam will be as low as possible without being [illegible] at ordinary low water stage. A similar arrangement of slot and sill is provided for coffering the tail bay. With the object of preventing the water from cutting behind the land wall, its upper and lower end is, in each lock, provided with a wing wall running perpendicularly back into the bank far enough to join the rocky bluff which is from 20 to 30 ft. in the rear. The thickness of these walls is 4 to 6 ins. on top, increasing downward by offsets until rock foundation is reached.

There are two filling culverts each 3 ft. 3 ins. by 7 ft., which are placed in the gate recesses to keep them from filling with mud; these culverts discharge into a large cross culvert in the upper miter wall and thence through 8 small lateral openings into the lock chamber, thus dividing the water into small streams emptying near the lock floor so as to cause little disturbance to boats. For emptying the lock there are two side culverts, each 4 by 5 ft., which pass around the heels of the lower gates entering near the gate recesses and discharging below the miter wall into the tail bay, thus serving to prevent deposits there.

View of Dam No. 1, Showing Abutment as Originally Constructed.

The forms used in the concrete work on the lock were of the usual type, namely, plank or lagging laid horizontally and held rigidly by outside posts, solidly braced to the ground so as to prevent the ramming from springing them. Yellow pine lumber was used. The lagging was 2 ins. thick and 12 ins. wide, and was dressed on all four sides. The posts were 4 x 6-in. scantling, spaced 4 ft. apart and were supported at about 8 ft. intervals by inclined braces of 4 x 6-in. scantling. The forms were built in separate alternate sections, the lagging for each section being carried to the full height before concreting was started in that section, and the concreting for each section of wall being completed before another section was begun, as the work was in two 8-hour shifts, the sections are not monoliths. These posts of the forms were tied together at the top by two rows of ½-in. or ⅝-in. round iron tie-rods. Forms were left in position from four to five days after concreting was completed.

The cost of the forms was as follows:

Forms

Materials—	Unit Cost.	Total.	Per M.ft.
Lumber, 159 M. ft.	$11.40	$1,818	$11.40
Iron and nails		360	2.26
Total		$2,178	$13.66
Labor			
Inspecting lumber 15.6 M	.3897	6	.04
Hauling lumber		78	.49
Erect'g, etc., 159 M. ft.	15.20	2,430	15.29
Total		$2,514	$15.72
Grand total (159 M. ft.)....		$4,692	$29.38

The total labor time in days in erecting, etc., was 1,218⅜ days, and the work done per man per day was 130.5 ft. B. M.

The concrete mixer was a 4-ft. cubical box of ½-in. riveted steel securely fastened at diagonally opposite corners to a 3-in. steel shaft bored for about half its length with a 1-in. hole for the admission of water. Near one corner was a 15 x 20 in. hinged door for the admission of the dry materials. The mixer was operated by a center crank engine with 6 x 7-in. cylinder and was located on the bank approximately opposite the center of the lock. The concrete was placed by derricks. A Y track led from the mixer parallel to and about 18 ft. back of the land wall to within easy reach of two stiff-leg derricks, so located as to command the entire lock wall. The mixer charge was dumped into skips, which were taken from the cars by derricks and the concrete deposited in place in the lock walls. Upon the completion of the land wall the derricks were placed on this wall, where they commanded the river wall. The concrete was placed in layers 10 ins. thick.

In the concrete work Portland cement only was used, the brands being Lehigh and Alpha. The cement varied in price from $1.82 to $2.70 per barrel delivered on cars at Birds Point, Mo.; from there it was transported as far as Newport, Ark., over a land-grant railroad, and from Newport to Batesville, the freight charges were approximately 11 cts. per barrel. The sand used was a coarse, sharp, clean sand from the Arkansas River, near Little Rock, and cost 33 cts. per cubic yard delivered at Little Rock. To this sum should be added 26 cts for freight and 38 cts. for hauling from the Batesville depot to the lock site.

The gravel used was dredged by hired labor, from the river near the works; it consisted of a mixture of pebbles of all sizes with about 19 per cent sand. It was not washed, as bars were found where the gravel contained only clean sand. This river gravel contained usually from 17 to 21 per cent of voids. It cost delivered in bin, including all charges, 25 cts. per cubic yard. The stone used was a sandstone, the so-called bluestone of Cabin Creek, Arkansas, which, tested at Watertown Arsenal, had shown an ultimate strength of 17,700 to 19,700 lbs. per square inch. It cost 70 cts. per cubic yard at Cabin Creek; the freight charges amounted to 25 cts. per cubic yard and the hauling from the depot to the works 60 cts. a cubic yard. All stone was broken into fragments small enough to pass through a 2-in. ring. The voids averaged 51 per cent. The stone was required to be screened, though the run of the crusher would have been preferable.

The proportions of the mix varied, the concrete being richer in the foundations, on exposed surfaces, and when gravel was used. It was the intention to use crushed stone concrete for a depth of 4 ft. on all exposed surfaces and gravel concrete elsewhere, but in the construction of this lock, owing to the irregularity of the delivery of the stone, gravel-concrete was used whenever necessary to avoid stopping the work. Three mixtures were used in the walls, depending upon the supply of materials on hand, viz.: 1 part cement, 2½ sand, and 6½ gravel; 1 part cement, 3 sand, 6½ gravel; 1 part cement, 3 sand, 4 gravel, and 2 broken stone. Less sand was used with the straight gravel mixture than with the broken stone because of the large per cent of sand contained in the river gravel. The amount of water had to be varied frequently. It was regulated by judgment, according to the appearance of the mortar.

The cost of mixing and placing the concrete for the lock, was as follows:

Materials—	Unit Cost.	Total.	Per cu. yd. Concrete.
Cement, Lehigh, 4,051 bbls.	$2.45	$9,925	$1.12
Cement, Lehigh, 841 bbls..	1.97	1.657	.18

Cement, Alpha, 4,992 bbls..	2.20	10,982	1.24
Crushed stone, 2,256 cu.yds.	.70	1,579	.17
Crushed stone, 92 cu. yds..	3.25	299	.03
Sand, 3,096 cu. yds........	.35	1,022	.11
Gravel, 12.9 cu. yds........	.50	6	..
Fuel		537	.06
Illuminating oils		314	.03
Total materials		$26,322	$2.94
Labor—	Unit Cost.	Total.	Per cu. yd. Concrete
Mixer frame	....	$153	$0.017
Insp. of cement, 9,884 bbls.	$0.022	223	0.025
Inspect'n of crushed stone, 2,348 cu. yds.............	.101	238	.026
Insp. of sand, 3,096 cu.yds.	.069	212	.024
Storing cement, 2,500 bbls.	.079	199	.021
Haul'g cement, 9,690 bbls.	.08	775	.086
Hauling crushed stone, 2,078 cu. yds............	.60	1,247	.140
Haul'g sand, 3,053 cu.yds..	.38	1,160	.130
Dredg. gravel, 6,125 cu.yds.	.105	646	.072
Unloading gravel for hand mixed concrete, 385 cu. yds.	.181	70	.008
Hoisting gravel for machine mixed concrete, 5,025 cu. yds............	.473	2,378	.266
Mixing and placing machine mixed concrete, 7,858 cu. yds............	.568	4,464	.499
Mixing and placing hand mixed concrete, 1,081 cu. yds.	1.83	1,981	.221
Tamping machine mixed concrete, 7,858 cu. yds..	.328	2,581	.288
Tamping hand mixed concrete, 1,081 cu. yds......	.443	479	.053
Finishing top of lock wall, 548 cu. yds	.104	57	.006
Total labor		$16,864	$1.88
Grand total, 8,939 cu. yds. concrete		$43,186	$4.83

Eng.-Contr.

View of Dam No. 1, Showing Dam Extension and New Abutment.

Cost of concrete, including forms ....$5.36 per cu. yd.

Some of the labor items can be further summarized as follows:

	Work Done.	Labor Time in Days.	Work Done per Man per Day.
	bbls.		bbls.
Inspection of cement	9,884	73 6/8	139.21
Storing cement	2,500	94 5/8	26.32
	cu. yds.		cu. yds.
Inspection of crushed stone	2,348	71	21.15
Inspection of sand...	3,096	111	23.63
Dredging gravel	6,125	306 2/8	20
Unloading gravel for hand mixed concrete	385	41	9.39
Hoisting gravel for machine mixed concrete	5,025	1,308	3.84
Mixing and placing machine mixed concrete	7,858	2,384 3/8	3.29
Mixing and placing hand mixed concrete	1,081	1,103 4/8	.98
Tamping machine mixed concrete.....	7,858	1,420 1/8	5.53
Tamping hand mixed concrete	1,081	283	3.82
Finishing top of lock wall	548	29 5/8	18.27

Lock Gates, Miter Sills, Etc.—The lock gates are of the standard form, namely, mitering gates of the girder type with straight back and front. They are horizontally framed and without quoin or miter posts, the main timbers extending from edge to edge of the gate and the ends, which are built up solid with filling blocks, being shaped to fit the hollow quoin and miter, respectively, thus avoiding the weakness of beams jointed into vertical heel and toe posts. The rise was taken as 1-6 of the span, which is equivalent to a miter angle of 18 degrees 26 minutes.

The gates are of white oak, 20 ins. thick throughout, each arm consisting of a built-up beam composed of two 10 by 10-in. timbers bolted together with 1-in. bolts and extending in one length from toe to heel. The tops of the gates are flush with the tops of the lock walls, so that the lock can be used until the walls are submerged. The lower gates, which are 29 ft. 5 ins. in height, are built solid for 10 ft. from the bottom. For the upper gates these figures become 15 ft. 5 ins. and 20 ins., respectively. By making the lower portion of a gate solid, the gate may be made thinner, thus reducing under pressure. The upper portions of the gates are paneled; the arms are all made of the same scantling as below, but are spaced inversely as the maximum loads; the arms are separated by five blocks (including the two at the heel and toe), and the intervals are closed with a sheathing of 2-in. oak plank made watertight by calking. The beams are held together by seven pairs of long 1⅛-in. bolts running vertically through the center lines of the main timbers as well as through the filling blocks in the upper part of the gate. The weight of the gate is taken up by two diagonal tie straps of 3½ by ¾-in. wrought-iron eyebars provided with turnbuckles; one end of each eyebar passes over a pin in the journal strap and the other over a similar pin held in place near the lower end of the toe by a stirrup strap and a nose strap. The bottom beam is fitted at the quoin with a cast-iron heel piece which rests on a forged steel pivot shrunk into a cast-iron pivot plate having sufficient bearing. This bedplate is bolted to the concrete. The top gudgeon is a 3-in. steel pin supported at both ends by journal castings, between which the collar works. In order that the leaf may, in opening and closing, swing clear of the quoin without friction, the rotation axis of the pivot and gudgeon is on the upstream side of the center of figure of the hollow quoin when the leaf is closed, the eccentricity being 1¾ ins. The upstream half of the toe is rounded off so that the surface of contact when the gates are mitered shall fall upon the downstream timbers of the built-up beams. Thus the compression due to the end reactions is thrown on the downstream timbers where it will relieve the tension from the direct loading, and is removed entirely from the upstream timbers to avoid increasing the compression from the direct loading.

The anchorage for the gates consists of four wrought-iron bars with cast iron washers or anchor plates embedded in the concrete and connected in pairs at their exposed ends to two heavy castings. The anchorage connections fit in a recess below the coping and are covered with a cast iron plate.

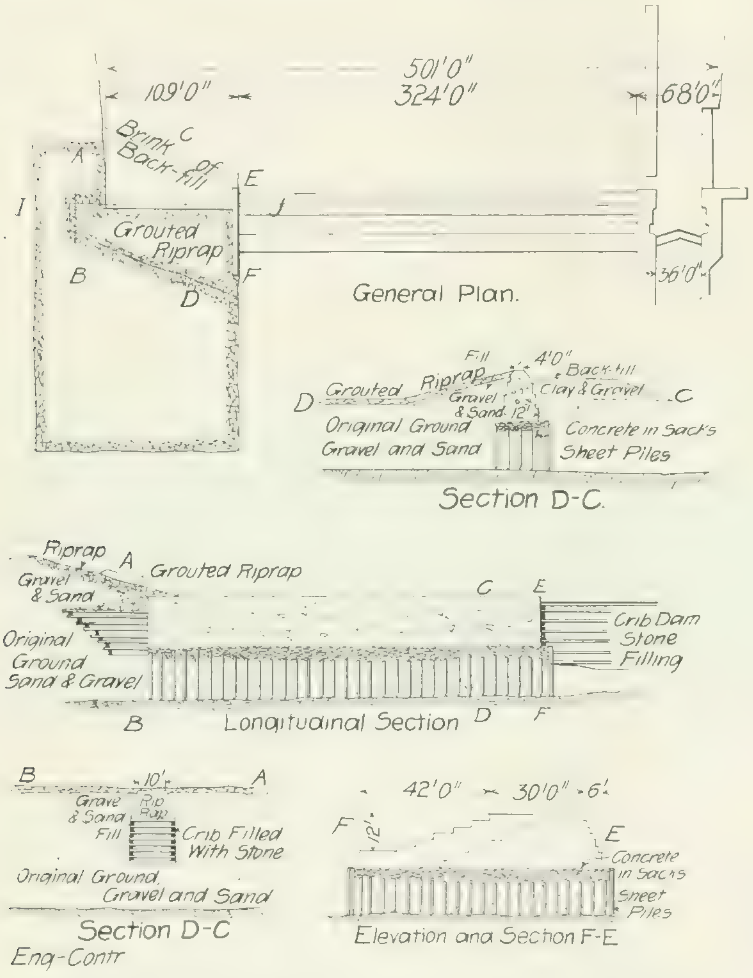
The method of building and placing the lock gates was as follows:

A small hand-power derrick was erected on a level spot so as to command the ways, which were built of heavy timbers laid perfectly level about 2½ ft. from the ground and close enough together to support without deflection the weight of an entire gate. On each side of the derrick were placed two sets of ways, between which ran a track for carrying the timbers. The gate timbers were delivered as needed to the derrick and placed on the ways, the built-up beams framed and bolted, and the heel and toe worked to pattern. The arms and blocks were then juxtaposed in position so as to get the alignment of the long bolts and then separated for the holes to be bored. This was a tedious procedure, as no matter how carefully the measurements for the holes were made it was found impossible to bore all of them in the different pieces so as to avoid slight errors of alignment; hence burning the holes out with long rods of hot iron had to be resorted to. The gate was then assembled, the bolts inserted and tightened, the irons fitted on, the heel and toe worked to pattern, and each arm and block numbered to avoid any displacement later. The gates were then taken apart and transported to the lock pit to be erected piece by piece, for which a land derrick was used. As each beam was put into position its top was given a heavy coat of white lead, and the position of its bolt holes tested by thrusting down an iron rod. After the gate had been thus built up to the required height, the long perpendicular bolts were raised by the derrick and put into place, the various irons fitted, the anchor bars and tie straps tightened, and the gate swung. The gates were then given two coats of red lead.

The gates are operated by hand power. The maneuvering gear consists of a spar, to each end of which is fastened one end of a chain; the bight of this chain is led through a chain guide consisting of two sheaves to a chain capstan worked by a crank. The gate is opened or closed according as the chain is pulled in one direction or the other.

As wooden lock gates subject to varying lifts, unless made too heavy at low water, are too buoyant at high water, it is necessary at the approach of floods to ballast them, which was done by filling the panels with large stones.

The miter sills, which provide an elastic cushion for the bottom of the gates, consist of 12 by 12 in. timbers well bolted to the miter wall, as they may sometimes be subjected to a lifting pressure from the gates, and when once started the upward water pressure is of course added. The miter sills are 2 ins. higher than the miter walls so as to act as a guard for the masonry. The miter sills are 1 ft. below normal 4 ft. depth, so as to permit the pool level to be reduced without affecting navigation. The sills, like the gates, are of white oak and were set when the concrete was placed in the miter walls. The gates do not, when shut, extend over the sill, as is sometimes the case, for a difficult joint then becomes necessary. In this instance the gates lap the sill by 5 ins., the under pressure being counterbalanced by the weight of the gates.



General Plan of Original Dam and Abutment as Completed February, 1901, and Sections of the Abutments.

The cost of the gates and sills was as follows:

	Unit Cost.	Total.
Lumber, oak, 35.7 M. ft. B. M.	$41.37	$1,477
Iron, wrought, 342 lbs.	.05	17
Iron, wrought, 16,243 lbs.	.06	975
Iron, wrought common, 153 lbs.	.023	4
Iron, cast, 600 lbs.	.046	28
Iron, cast, 5,354 lbs.	.045	241
Steel, 615 lbs.	.065	40
Journal castings and patterns		22
Total materials		$2,803
Labor—		
Inspect'n of lumber, 33.9 M. ft.	$0.3897	$13
Hauling miscel. material	...	15
Framing, 35.7 M. ft.	43.28	1,545
Setting gates, 4	76.54	306
Care, repair and adjusting since 1901, 4	...	887
Total cost of labor		$2,766
Grand total		$5,569

The total labor time in days for framing was 684 4-8 and the work done per man per day was 52.1 ft.; the total labor time for setting the four gates was 149⅛ days.

Valves, Ladders, Etc.—The valves in the culverts previously mentioned, are butterfly or balanced valves of steel plates and angles turning on vertical shafts. There are two valves to each filling culvert because the valves had to be of low height in order to remain submerged during low water. They are 3 ft. 2 ins. by 3 ft. 2 ins. in size. The wicket is set in a cast iron frame bolted to the concrete and is protected from debris by a movable screen sliding vertically in guides bolted to the walls. The valve operating gear, which is set in a covered recess in the coping, consists of a gear sector keyed to the top of the valve shaft and geared with a pinion turned by a rachet wrench and wheel. Two recessed ladders are placed in each chamber wall of the lock.

The cost of the valves, ladders, etc., was as follows:

Materials—	Unit Cost.	Total.
New valves and foundry work on same, 2	$267.00	$534
Iron, wrought, 5,397 lbs.	.06	324
Iron, cast, 7,737 lbs.	.045	348
Steel, 6,976 lbs.	.065	543
Total materials		$1,749
Labor—		
Hauling iron, etc.	...	$16
Placing 20,110 lbs.	$0.02	406
Total labor		$422
Grand total		$2,171

Filling, Grading, Etc., Behind Land Wall.—Loose stone was placed by hand back of the land wall to form a drain for the seepage. This drain was about 2 ft. by 3 ft. in cross section and was connected with a 6-in. cast iron pipe leading through the lower end of the land wall into the guide crib. The space behind the land wall and between the wing walls was then filled with gravel to the level of the top of the walls and paved with selected riprap stone set on edge, carefully placed by hand and rammed. A coat of gravel was then scattered over the paving and swept into the interstices. In the rear of this level space the bank was graded and the paving of hand-laid gravel coated riprap continued to flood level so as to prevent floods from washing out the backings.

The cost of making the fill behind the land wall was as follows:

Filling (4,262 cu. yds.).

Material—	Unit Cost.	Total.	Per cu. yd. Fill.
Fuel	.....	$268	$0.062
Illuminat'g oils, etc.	.....	70	.016
Total materials.		$338	$0.078
Labor—			
Removing incline	.....	$25	$0.006
Dredging gravel, 4,262 cu. yds.	$0.108	459	.107
Hoisting and filling, 4,262 cu. yds.	.6145	2,619	.614
Total labor		$3,103	$0.727
Grand total (4,262 cu. yds. filling)		$3,441	$0.805

The total labor time in dredging gravel was 204 2/8 days and the work done per man per day was 20.89 cu. yds.; total labor time in hoisting and filling was 1,499 6/8 days, the work done per man per day being 2.841 cu. yds. The total labor time in filling was 1,719 days, the average amount of filling done per man per day being 2.479 cu. yds.

The cost of grading and paving behind the land wall was as follows:

Material—	Unit Cost.	Total.	Per sq. yd. Paving.
Riprap stone, 798 cu.yds.	$0.74	$590	$0.307
Cement, 5 bbls.	1.97	10	.006
Total materials		$600	$0.313
Labor—			
Insp. of riprap stone, 798 cu. yds.	$0.008	$6	$0.003
Insp. of cement, 5 bbls.	.022	....	....
Grading and pav'g 1,916 sq. yds.	.495	947	493
Total labor		$953	$0.496
Grand total, 1,916 sq. yds.		$1,553	$0.810

The total labor time for the 1,916 sq. yds. of grading and paving was 550⅛ days, the work done per man per day being 3.49 sq. yds.

Guide Cribs.—At the head and foot of each lock wall permanent guard or guide cribs were placed. The upper river crib is a solid crib, containing the line of the river wall. It is 150 ft. long and 8 ft. wide on top. The inside face is vertical from the top to 1 ft. below the upper miter sill, below which it is stepped, as is the outer face, so that the width of the base 30 ft. below the top is 20 ft. The lower part of the crib work connects with the lock wall, but above a level 2 ft. below the upper miter sill there is a gap 10 ft. wide between the crib and the lock wall for the passage of drift. The top of the crib is level with the coping.

The lower river crib is 150 ft. long and is similar to the upper crib except that there is no gap between the crib and the lock walls, and that the top of the crib is not level with the coping throughout, that portion farthest down stream being 5 ft. below the coping in elevation.

The land cribs are in line with the lock walls, the upper one being 66 ft. long and the lower one 20 ft. The cribs were built of 10x10-in. timbers, framed and drift bolted together, pine being used below pool level and oak above. The cribs are filled with one-man stone, large selected stones being set on edge with their flat faces against the side openings, the top being covered with large, well shaped stones set level with the timbers.

The cost of the upper land crib was as follows:

Material—	Unit Cost.	Total.	Per M.ft. in Crib.
Lumber, pine, 30 M. ft B. M.	$18.20	$546	$18.20
Riprap, 602 cu. yds.	.74	445	14.83
Iron, 2,350 lbs.	.0026	63	2.10
Total materials		$1,054	$35.13
Labor—			
Excavating 45 cu. yds.	$1.89	$85	$2.83
Insp. of timber, 30 M.ft.	.39	12	.40
Riprap, 602 cu. yds.	.008	5	.16
Building and filling, 30 M. ft.	15.42	463	15.43
Backfill, 180 cu. yds.	.525	95	3.16
Total labor		$660	$21.98
Grand total (30 M. ft.)		$1,713	$57.10

The labor items in the above work that can be further summarized are as follows:

Work Done—	Labor Time in Days.	Work Done Per Man Per Day.
Excavating, 45 cu. yds.	46 7/8	.957 cu. yd.
Building and filling, 30 M. ft.	259 6/8	.115 M. ft.
Backfilling, 180 cu. yds.	44 4/8	.404 cu. yd.

The cost of the lower land crib was as follows:

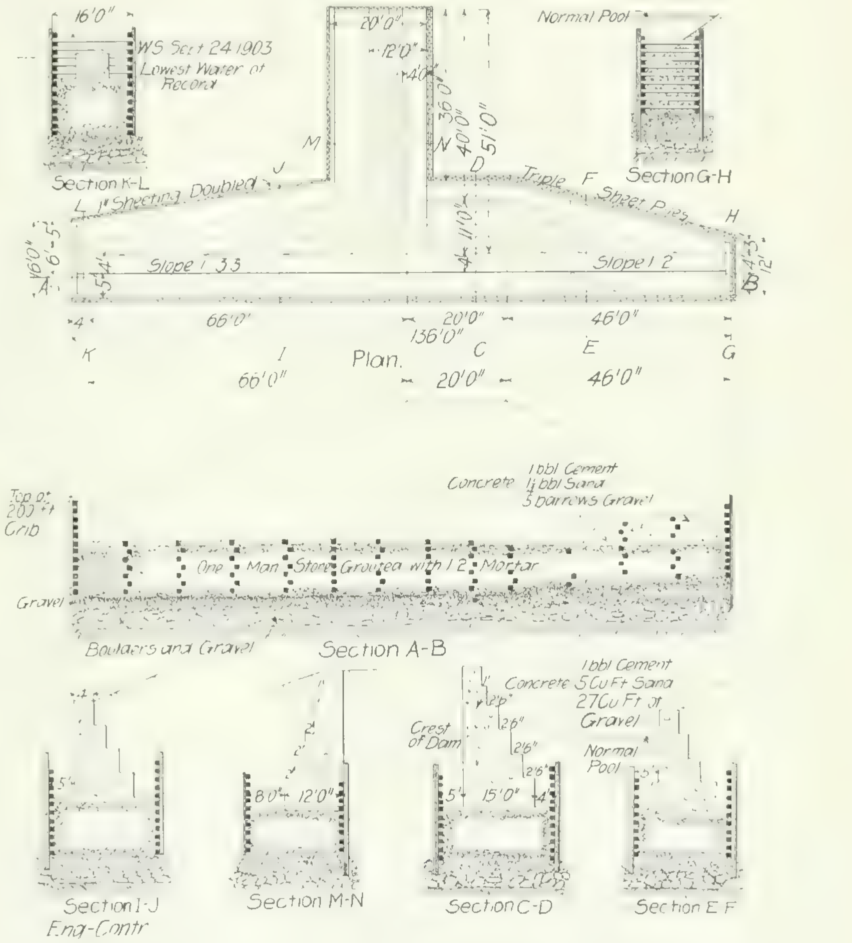
Material—	Unit Cost.	Total.	Per M. ft. in Crib.
Lumber, pine, 9.3 M. ft.	$18.15	$169	$18.15
Riprap, 145 cu. yds.	.74	107	11.51
Iron, 413 lbs.	.026	11	1.12
Total materials		$287	$30.78
Excavation labor—			
Earth 92, rock 15, 107 cu. yds.	$3.26	$242	$26.02
Building and filling, 9.3 M. ft.	....	275	29.65
Insp. of timber, 4 M. ft.	.39	2	.21
Inspection of riprap, 65 cu. yds.	.008	[illegible]	...
Total labor		$519	$55.88
Grand total (9.3 M. ft.)		$806	$86.66

The cost of the upper river crib was as follows:

Material—	Unit Cost.	Total.	Per. M.ft. in Crib.
Lumber, oak, 15.6 M. ft. B. M.	$20.12	$314	$6.60
Lumber, pine, 32 M. ft. B. M.	14.90	477	10.02
Iron and spikes, 1,620 lbs.	.028	46	.93
Riprap, 1,315 cu. yds.	.74	973	20.47
Total cost materials		$1,810	$38.02
Labor—			
Excavation		$50	...
Framing and placing timbers, 47.6 M. ft.	$10.32	$491	....
Filling with riprap, 1,135 cu. yds.	.31	410	....
Total labor		$951	$19.98
Grand total (47.6 M. ft.)		$2,761	$58.00

The average costs of crib materials may be summarized as follows:

	Per cu. yd.
Average cost of riprap, delivered	$ .74
Average cost to place	.436
Average cost in place	1.176



Plan and Sections of New Abutment as Completed, December, 1903.

The following is the cost of the lower river crib:

Material—	Unit Cost.	Total.	Per M.ft. in Crib.
Lumber, oak, 14.8 M. ft. B. M.	$16.82	$249	$5.39
Lumber, pine, 31.3 M. ft. B. M.	14.97	469	10.16
Riprap, 1,014 cu. yds.	.74	714	15.46
Iron and spikes, 5,420 lbs.	....	132	2.86
Fuel		21	.45
Total cost materials	....	$1,585	$34.33
Labor—			
Excavating, 980 cu. yds.	$0.039	$39	$0.84
Framing and placing timbers, 46.2 M. ft.	15.60	721	15.60
Filling with riprap, 1,014 cu. yds.	.447	455	9.85
Inspection of lumber, 8 M. ft.	.39	3	.06
Inspection of riprap, 90 cu. yds.	008	.72	.02
Total labor		$1,219	$26.37
Grand total (46.2 M. ft.)		$2,804	$60.69

	Per M. ft.
Average cost of crib timber, delivered	$13.82
Average cost to place timber	9.29
Average cost of crib timber in place	23.11

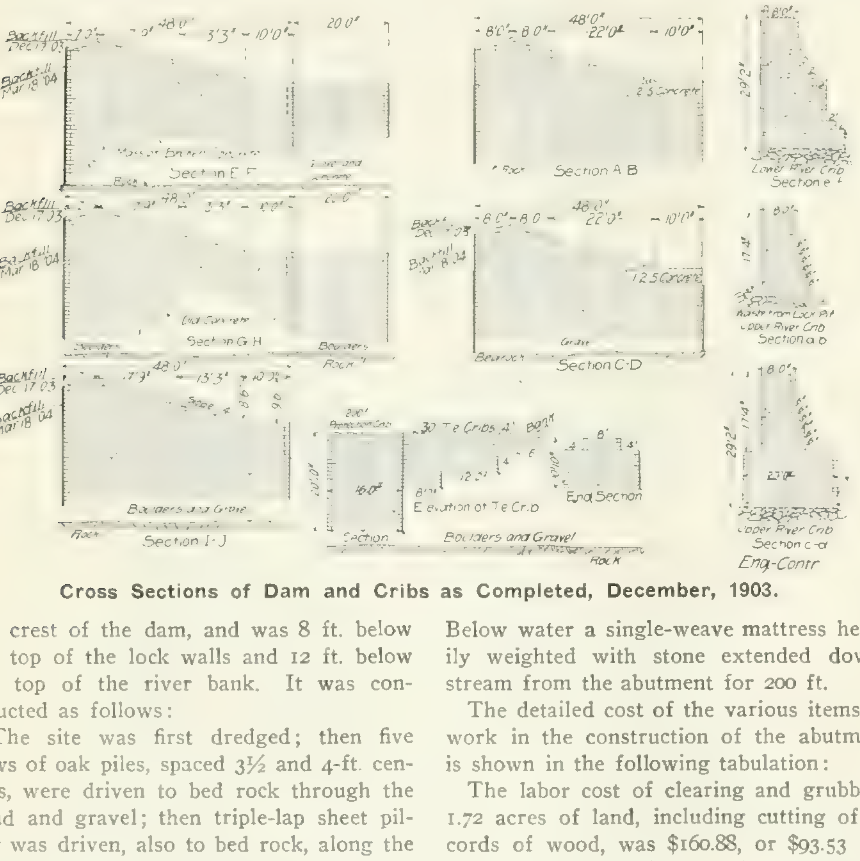
The above costs include field supervision and subsistence, but do not include freight on timber, which is about $1 per M. ft.

Summary of Lock Work:

	Total.	Unit Cost.
Clearing site (4 acres)	$ 204	$51.00
Cofferdam (462 lin. ft.)	8,487	18.37
Excavation (3,635 cu. yds.)	5,758	1.58
Forms (159 M. ft.)	4,692	29.38
Concrete (8,939 cu. yds.)	43,186	4.83
Gates and sills	5,569	.....
Valves, ladders, etc	2,171	.....
Filling behind land wall (4,262 cu. yds.)	3,441	.805
Grading and paving same (1,916 sq. yds.)	1,553	.810
Excavating upper approach	388	...
Excavating lower approach	182	.....
Upper land crib (30 M. ft.)	1,713	57.10
Lower land crib (9.3 M. ft.)	806	86.66
Lower river crib (46.2 M. ft)	2,804	60.69
Upper river crib (47.6 M. ft)	2,761	58.00

ABUTMENT AT DAM NO. I.

The abutment at dam No. 1 was begun in August, 1900, and completed in February, 1901. Though located in a narrow part of the river it was not only not put into the bank as far as practicable to increase the spillway, but on the contrary was placed 120 ft. in front of the river bank. It was of concrete, on a pile foundation, and was of the T type, the river face being 30 ft. long on top and 78 ft. long at the base. Its stem or land arm, which was 128 ft. long measured from the face of the abutment to the extreme end of the stem, entered the bank only 8 ft., though this defect in providing a safe anchorage against possible flanking was in a slight measure remedied by placing a crib filled with riprap in prolongation of the stem for the further distance of 12 ft. measured at the bottom of the concrete wall, this distance increasing to 28 ft. at the top of the crib by the slope of the excavation. The top of the abutment was only 2 ft. above the crest of the dam, and was 8 ft. below the top of the lock walls and 12 ft. below the top of the river bank. It was constructed as follows:



Cross Sections of Dam and Cribs as Completed, December, 1903.

The site was first dredged; then five rows of oak piles, spaced 3½ and 4-ft. centers, were driven to bed rock through the sand and gravel; then triple-lap sheet piling was driven, also to bed rock, along the face and each end of the river wall, though not along the stem of the abutment. After the sheet piles had been driven, concrete in coarse gunny sacks was deposited over the area in from 3 to 5 ft. of dead water. It may here be mentioned that this concrete was in 1903, over two years afterwards, rendered plainly visible by the dredging undertaken around the abutment, which meanwhile had been flanked, as the water was lower than when the abutment was built. The sacks separated from each other readily; many of them were dug up by the orange peel bucket, and in no case did two sacks adhere. They could be seen caving off as the dredge undermined the work, behaving like separate pieces of stone and showing that no bond of any consequence existed between them. On this substructure of concrete in sacks a wall of concrete in mass from water level up was built with a 3½-ft. berm around it. The wall was 16 ft. high and 4 ft. thick on top and was stepped on the upstream and downstream sides. The stem wall was 12 ft. thick at bottom and the river wall 9 ft. thick. The concrete was all hand mixed, the proportions being 1 part Lehigh Portland cement, 2 parts sand, and 6 parts gravel. The material was mixed on barges and placed both by wheelbarrows and derrick boat. Above low water the abutment was protected for 50 ft. upstream and 200 ft. downstream by a revetment of riprap extending to the top of the bank. On the downstream side of the abutment for about 70 ft. from the river end of the stem and about 20 ft. from the land end, this riprap was grouted with 1 to 3 cement mortar. Below water a single-weave mattress heavily weighted with stone extended downstream from the abutment for 200 ft.

The detailed cost of the various items of work in the construction of the abutment is shown in the following tabulation:

The labor cost of clearing and grubbing 1.72 acres of land, including cutting of 32 cords of wood, was $160.88, or $93.53 per acre. The labor time in days was 86⅜ and the work done per man per day was .02 of an acre.

The cost of the excavation work was as follows:

	Unit cost.	Total.	Per cu. yard.
Fuel	....	$ 97	.007
Excavation by teams and dredges	$0.04	523	.04
Total (13,081 cu. yds.)		$620	.047

The following is the cost of the timber and pile foundation:

Material.	Unit cost.	Total cost.
Iron, spikes and bolts, 1,640 lbs.	....	$ 54
Forms, 739 ft. B. M.	.10	7
Sheet piles and grillage, 56.3 M ft. B. M.	....	874
Main piles, 4,810 lin. ft.	0.06	289
Fuel	....	33
Total cost materials		$1,257
Labor:		
Driving main piles, 4,810 lin ft.	$0.107	$ 513
Driving sheet piles and placing grillage, 56.3 M. ft.	.....	502
Inspection of timber, 18.2 M. ft	.389	7
Construction of forms, 739 ft. B. M.	.....	35
Total labor		$1,057
Grand total		2,314

The total labor time required in driving 4,810 lin. ft. of main piles was 250 6/8 days, the work done per man per day being 19.18 lin. ft. of piles driven.

Concrete (1,127 cu. yds.).

Material:	Unit cost.	Total.	Per cu. yd. concrete.
Sacks, 4,500	$0.0427	$ 192	$0.17
Cement, Lehigh, 1,342 bbls.	1.97	2,644	2.35
Sand, 200 cu. yds.	.33	66	.05
Illuminating oils, etc.	....	104	.09
Total materials		$3,006	$2.66
Labor:			
Hauling cement, 1,342 bbls.	$0.08	$ 107	$0.09
Hauling sand, 200 cu. yds.	.38	76	.06
Hauling sacks	...	.75	...
Inspection of cement, 1,342 bbls.	.0225	30	.02
Inspection of sand, 200 cu. yds.	.0685	14	.01
Mixing and placing by hand, 1,127 cu. yds.	2.071	2,334	2.07
Tamping, 1,127 cu. yds.	.169	191	.18
Total labor		$2,752	$2.44
Total cost of concrete in place		5,759	5.10

Summarizing some of the labor items we have:

Work Done—	Labor Time in Days.	Work Done Per Man Per Day. bbls.
Inspection of cement, 1,342 bbls.	10	134.2
		cu. yds.
Inspection of sand, 200 cu. yds.	10	20
Mixing and placing by hand, 1,127 cu. yds.	1,296 6/8	.867
Tamping, 1,127 cu. yds.	107 1/8	10.52

Grading and Backfill (4,690 cu. yds.).

	Unit Cost.	Total.	Per cu. yd. Riprap.
Riprap, 114 cu. yds.	$0.74	$84	$0.018
Inspection of riprap, 114 cu. yds.	.008	.91	....
Grading and backfill, 4,690 cu. yds.	.185	865	.185
Total		$951	$0.203

The labor time for the 4,690 cu. yds. of back filling and grading was 430⅜ days, the work done per man per day being 10.898 cu. yds.

Protection Mattress (293 sq. yds.).

	Unit Cost.	Total.	Per sq. yd.
Riprap, 320 cu. yds.	$0.74	$237	$0.808
Inspection of riprap, 320 cu. yds.	.008	3	.010
Cutting and hauling brush, 169 cords	1.669	282	.962
Weaving and sinking, 293 sq. yds.	1.344	394	1.344
Total		$916	$3.124

The total labor time for cutting and hauling 169 cords of brush was 154 4-8 days, the work done per man per day being 1.09 cords; the total labor time for weaving and sinking 293 sq. yds. of mattress was 223 2/8 days, the work done per man per day being 1.31 sq. yds.

Cement Laid Pavement (633 sq. yds.).

Material—	Unit Cost.	Total.	Per sq. yd.
Riprap, 211 cu. yds.	$0.74	$156	$0.246
Cement, 51 bbls.	1.97	100	.158
Total		$256	$0.404
Labor—			
Inspection of cement, 51 bbls.	.0225	$1	$0.001

Inspection of riprap, 211 cu. yds.	.008	2	.003
Placing riprap, 211 cu. yds.	.65	137	.216
Total		$140	$0.220
Grand total		$396	$0.624

The total labor time for placing the 211 cu. yds. of riprap was 76 6/8 days, the work done per man per day being 2.75 cu. yds.

Bank Revetment (3,588 sq. yds.).

	Unit Cost.	Total.	Per sq. yd.
Riprap, 1,235 cu. yds.	$0.74	$914	$0.254
Inspection of riprap, 1,235 cu. yds.	.008	10	.002
Placing riprap, 1,235 cu. yds.	.245	302	.084
Total		$1,226	$0.340

The labor time for placing the 1,235 cu. yds. of riprap was 155 6/8 days and each man placed an average of 7.92 cu. yds. of riprap per day. On the basis of 3,588 sq. yds. of revetment each man placed an average of 2.3 sq. yds. per day.

Additional Protection Before Flanking.

	Unit cost.	Total.
Lumber, pine, 5.032 ft. B. M.	$14.73	$74
Riprap, 814¼ cu. yds.	.68	555
Cost of material		$629
Labor, 218⅝ days		425
Total cost		$1,054

Summary of Old Abutment.

	Total.	Unit Cost.
Clearing and grubbing (1.72 acres)	$161	$93.53
Excavation (13,081 cu. yds.)	620	.047
Pile foundations	2,314	....
Concrete (1,127 cu. yds.)	5,759	5.10
Grading and backfill (4,690 cu. yds.)	951	.203
Protection mat (293 sq. yds.)	916	3.124
Cement laid pavement (633 sq. yds.)	396	.624
Bank revetment (3,588 sq. yds.)	1,226	.340
Additional protection before planking	1,054	....

DAM NO. I.

Dam No. 1 was a timber crib structure placed normal to the axis of the river and resting against the buttress of the upper river lock gate, so as to have the whole length of the lock chamber in the lower pool. The dam was 324 ft. long. For the 210 ft. next to the lock it is founded on rock, the remainder of it resting on gravel. The width at the foundation is 48 ft., and the height above the foundation varies between a maximum at one place of 27 ft. (on rock) and a minimum of 19 ft. next to the old abutment. The cribs are of yellow pine except the slope timbers and the face stringers, which are of white oak. All timbers are 10x10-in. scantling and are drift bolted together at their intersections. The upstream face of the dam is vertical to within 2 ft. of the top, whence, to prevent catching drift, it slopes to the crest (a 12 by 12-in. comb stick), having a slope of 1 on 4. The downstream face sloped from the crest for 8 ft. with a slope of 1 on 4 and was stepped, having two steps each 8 ft. wide and an apron 16 ft. wide, the three vertical intervals being four courses of 40 ins. each. The upper slope was laid closely so as to be water tight; the timbers on the downstream side of the crest were spaced 1 in. apart. A short section of the dam about 9 ft. in length was in 1900 built inside the lock cofferdam up to the level of the apron. No further work on this dam was done until August, 1902, when work was recommenced by excavating with a dipper dredge. The dam was built in three separate sections, which were partially completed a short distance upstream, the bottoms being built to suit careful soundings previously taken, and then towed to position and the building continued. Only every other pen was filled with stone until the last section was in place and weighted. Triple-lap sheet piles, 9 by 12 ins., were driven to rock on the upper side of the dam for 110 ft. out from the abutment where the dam rested on gravel; the remaining portion of the dam, which is on rock, was merely sheeted with double-lap 1¼-in. plank. The lower side of the dam for 120 ft. from the abutment was also sheet piled for the purpose of holding the gravel. The dam was backfilled to within 4 ft. of the eave for about 20 ft. upstream, partly with gumbo and partly with gravel. Below that portion of the dam on gravel a brush mattress covered with 2 ft. of stone was laid.

The cost of this dam was as follows:

Excavation.

Materials—	
Fuel and oil	$96
Labor—	
181 2/8 days	367
Total	$463

Framing and Placing Timbers.

Materials—	Unit Cost.	Total.	Per M. ft.
Oak, 132.8 M. ft. B. M.	$19.81	$2,632	$5.07
Pine, 387.3 M. ft. B. M.	13.71	5,320	10.23
Iron, 25,297 lbs.	.025	655	1.25
Hauling lumber, 147.4 M. ft. B. M.	1.18	173	.33
Fuel, oil, etc.	....	173	.33
Boat spikes, 12 kegs	8.65	104	.20
Miscellaneous	....	12	.02
Total cost of material, 520.2 M. ft. B. M.	$17.43	$9,069	$17.43
Labor—			
Frame and place, 520.2 M. ft., B. M.	$8.84	$4,599	$8.84
Grand total		$13,668	$26.27

The labor time in days for framing and placing the 520.2 M. ft. B. M. was 2,392⅝ and the average amount framed and placed per man per day was 217 ft.

Driving Sheet Piles.

Materials—	Unit Cost.	Total.	Per M. ft. Piling.
Oak, 25.2 M. ft.	$19.81	$501	$19.81
Boat spikes, 2 kegs	8.50	17	.67
Total materials, 25.2 M. ft.	$20.48	$518	$20.48
Labor—			
Driving, 25.2 M. ft.	$22.54	$570	$22.54
Grand total		$1,088	$43.02

The total labor time for driving the 25.2 M. ft. of sheet piles was 315⅜ days, the work done per man per day being 80 ft. B. M. driven.

Filling (7,984 cu. yds.).

Materials—	Unit Cost.	Total.	Per cu. yd. Filling.
Riprap, 7,984 cu. yds.	$0.74	$5,908	$0.74
Coal (haul'g), 47.1 tons	.50	23	.003
Labor—			
Filling, 7,984 cu. yds.	.425	3,508	.428
Grand total		$9,439	$1.18

The total labor time for filling was 1,999 days, the average work done per man per day being 4 cu. yds. of filling.

Puddling (8,640 cu. yds.).

Material—	Unit Cost.	Total.	Per cu. yd. Pud'l'g.
Fuel and oil	....	$148	$0.017
Riprap, 60 cu. yds.	$0.74	44	.005
Labor—			
Digging and placing 8,640 cu. yds.	.277	$2,395	.277
Grand total		$2,587	$0.299

Repuddling (1904).

Labor, 4,550 cu. yds.	$0.336	$1,529	$0.336
Cost both years, 13,190 cu. yds.		4,116	.312

	Total.	Per lin. ft.
Dam, 324 lin. ft.	$28,774	$88.81
		Per cu. yd.
Dam, filling 7,984 cu. yds.	.....	$3.60

Summary of Dam No. 1.

	Total.	Unit Cost.
Excavation	$463	.....
Framing and placing timber, 520.2 M. ft.	13,668	$26.27
Sheet piles, 25.2 M. ft.	1,088	43.02
Filling, 7,984 cu. yds.	9,439	1.18
Puddling, 8,640 cu. yds.	2,587	.299
Repuddling (1904), 4,550 cu. yds.	1,529	.336
Protecting apron and end of dam after flanking of abutment (1903)	1,212	.....
Changing shape of old dam from step to slope (324 lin. ft.)	6,177	19.06

Changes in Dam.—After the failure of the abutment at the dam (described elsewhere in this article) the original portion of the dam was changed from a step to a slope dam and a concrete apron built. A 1—2—5 gravel concrete was used, a 1—2 mortar being adopted because most of the concrete had to be deposited under water. The cost of changing the dam from step to slope was as follows:

Material—	Unit Cost.	Total.	Per lin. ft. of Dam.
Oak, 58.7 M. ft. B. M.	$17.31	$1,015	$3.14
Oak hauled, 58.7 M. ft. B. M.	1.26	73	.22
Iron, 4,690 lbs.	.019	93	.29
Iron hauled, 4,690 lbs.	....	2	.01
Riprap, 408 cu. yds.	.74	302	.93
Fuel	....	41	.12
Cement, 785 bbls.	2.66	2,092	6.46
Cement hauled, 785 bbls.	.062	49	.15
Total		$3,667	$11.32
Labor			
Timber work	....	$1,187	$3.67
Obtaining gravel and sand and laying concrete apron, 573 cu. yds.	$1.80	1,031	$3.18
Filling, 408 cu. yds.	.69	281	.86
Inspection of riprap	....	11	.03
Total		$2,510	$7.74
Grand total cost of changing		$6,177	$19.06
Grand total cost of old dam (324 lin. ft.)		$35,323	$109.02

NEW ABUTMENT AT DAM NO. I.

The original abutment at dam No. 1 was completed in February, 1901, but the dam described in the previous paragraphs was not completed and the pool filled until October, 1902. During the short time the water surface in the upper pool remained below the top of the abutment the latter served its purpose satisfactorily. A rise in the river, however, brought the water over the top of the abutment, and the grouted riprap was attacked and began to be undermined at its lower end about 75 ft. below the center of the abutment. A timber bulkhead was immediately built to raise the height of the abutment and in this way the overflow was practically stopped. In the meantime, however, the area of the caving and undermining of the grouted riprap had increased until it extended back about 40 ft. and upstream about 35 ft., the settlement of the riprap over this area being about 5 ft. vertically. Finally, however, the bank below the abutment began to go, and the abutment was destroyed. To protect the exposed end of the dam a heavy layer of derrick stone was placed there. The dam itself was not damaged and, acting as a wing dam, served to concentrate the flow of the river around its end. No effort was made to stop the resulting erosion of the bank, as a longer spillway was desired.

The erosion resulting from this contracted flow and the deflection of the current caused the new bank line to make an angle of about 45 degs. with the original dam. It was decided, however, to prolong the dam in a straight line and also to build the river face of the abutment normal to it. This caused the new abutment, which was finally located 346½ ft. from the end of the original dam, to make an angle with the bank instead of being parallel to it, thus throwing its downstream end well out into the river. Bed rock at the abutment site was 18 ft. below extreme low water elevation and was covered by from 3 to 5 ft. of boulders, except that over a portion of the area the boulders had been removed by the current. Owing to the expense of building a cofferdam and the difficulty of holding it in position, it was decided to build the foundations by subaqueous grouting. Accordingly the abutment was founded on a timber crib filled with grouted rubble, the grout being fed from below to make the voids fill from the bottom upward.

Excavation.—The necessary excavation for the crib was done by dredging, a dipper dredge with orange-peel bucket being used. The water at this time was 4 ft. above extreme low water and the dredge used could dig to a depth of 16 ft., so that the foundation bed prepared for the crib was, allowing 6 ins. for oscillations of the water surface, at an average elevation above bed rock of 6½ ft., 3 ft. of which consisted of boulders, the remainder being coarse gravel. The cost of excavation was as follows:

Material—	Total.	Per cu.yd
Fuel and oil	$367	$0.016
Labor—		
Excavation, 1,021 days	$2,289	.096
Total, 23,738 cu. yds at $0.112	$2,656	$0.112

Foundation Crib.—The crib was T shaped in plan, following the general outline of the abutment. The length of the river face was 136 ft., its width was 12 ft. at the upstream end and 16 ft. at the downstream end, and 24 ft. near the middle for a distance of 37 ft., beginning 46 ft. from the upstream end. The portion of the crib underlying the stem of the abutment was 20 ft. wide and 60 ft. long from face to end; it entered the bank 35 ft. The crib, which was constructed of 10 by 10-in. squared timbers, was built afloat and with interior pens varying in size from 5 by 10 ft. to 10 by 12 ft. After having been settled in place it was filled with "one man" stone up to 2 ft. below extreme low water (6 ft. below water level at the time), the filling averaging 11 ft. in depth. Before this filling began, however, the distributing boxes for the grout were placed. These consisted of open-ended square boxes (8 by 8 ins. inside) of 2-in. plank perforated with 1½-in. holes spaced zizzag 1 ft. apart down the sides. They were long enough to reach just above a loosely laid floor on the top timbers and were set about 10 ft. apart throughout the crib. The cost of these boxes is given under grouting. After the grout boxes had been placed and the crib filled with rubble 9-in. tripple-lap sheet piling was driven with a steam hammer along the outside of the crib from a point opposite the downstream edge of the apron to the upstream end of the crib, and thence around the end and along the upstream face of the stem. The other faces of the crib were sheeted with double-lap 1-in. plank driven by hand mauls. The sheet piling was also for the purpose of preventing leakage under the abutments, otherwise the double sheeting of 1-in. plank would have answered throughout. The sheet piling and plank sheeting were well spiked to the top timbers of the crib. Gravel and earth were then deposited around the crib up to the water level for a double purpose: first to prevent the grout from forcing its way through the sheeting and second to serve as a cofferdam when the time came to pump out the crib.

The cost of this foundation crib was as follows:

Foundation Crib.

Material—	Total.	Per M. ft. of Crib.
Lumber, pine, 65.3 M. ft. B. M. at $11.36	$742	$11.36
Lumber, hauled, 50.3 M. ft B. M. at $1.25	63	.96
Iron, 5,123 lbs., at $0.023	119	1.82
Miscellaneous materials	100	1.53
Total cost of materials	$1,024	$15.67
Labor—		
Framing and placing, 65.3 ft., 981 2/8 days	$1,859	$28.47
Grand total	$2,834	$44.14

The average work done per man per day was 66.6 ft. B. M. of timber framed and placed.

Sheet Piles and Sheeting.

Materials—	Total.	Per M.ft. in Place.
Lumber, oak, 18.8 M. ft. B. M., at $15.79	$299	$10.40
Lumber, pine, 9.9 M. ft. B. M. at $13.99	139	4.82
Lumber, hauled, 9.9 M. ft. B. M., at $1.25	12	.86
Spikes, 800 lbs., at $0.031	25	.42
Total cost of materials	$475	$16.50
Labor -		
Driving, 28.7 M. ft., 334 days	$730	$25.43
Grand total	$1,205	$41.93

Filling with Riprap.

Material—	Total.	Per cu.yd
Riprap, 876 cu. yds., at $0.74	$648	$0.74
Labor—		
Filling and placing, 118 days	235	.27
Inspection of riprap, 10 days	18	.02
Grand total, 876 cu. yds. riprap	$901	$1.03

The average work done per man per day was 6.84 cu. yds. of riprap placed.

Grouting Foundation Crib.—The grout feeding boxes were placed inside the previously mentioned grout distributing boxes. They consisted of smaller open-ended square boxes made of 1-in. boards. These boxes, which were not perforated, measured 3 by 3 ins. on the inside and were at first just long enough to reach from the bottom to the top of the outside boxes. As the grout rose in the rubble, the inside boxes were raised and shortened to compensate for the depth filled. By feeding the grout through these smaller boxes, which delivered it almost intact at the bottom of the larger perforated ones, it had to enter the rubble from below upward, and being twice as heavy as water the filling of all the voids was practically insured. Had the grout been poured directly into the larger boxes it would have had to fall through a considerable depth of water. Had the larger grout boxes been omitted, it would have been necessary in the first place to have filled the crib as far up as the water surface with rubble, and in the second place the grout, being then necessarily simply poured on, could not have been relied upon to fill the interstices completely. For funnels to receive the grout as it flowed from the mortar boxes half barrels were placed on the working platform, each one with a 2-in. wrought iron pipe 4 ins. long inserted in its bottom, the pipe extending down into the feeding boxes. There were eight mortar boxes, 1 by 4.5 by 5 ft. in size, made of 2 by 12-in. pine, which were supported on legs 18 ins. above the floor. Each box had two sliding doors at opposite ends, and as the box was tilted slightly, the grout flowed freely into the short troughs which carried it to the funnels. The grout was a 1 to 2 mixture approximately, two level full barrels of sand being used to each barrel of cement. Later the shovelers cast the sand directly into the mortar boxes, 18 shovelfuls being considered equivalent to a barrel of sand. The sand and cement were placed in the boxes dry and mixed until the mass became a uniform color, then water was added until the grout was thin enough to flow freely, after which a sluice was opened and the grout poured, the mixing and stirring being continued both in the mortar boxes and in the half barrels as long as there was any grout left. The distributing boxes were fed alternately and the progress of the filling watched by sounding in them. When the grout had reached the top of the rubble, 6 ft. below water level, the inclosed area was pumped out by means of a centrifugal pump. A stream of water flowing upward through the grouted rubble was then discovered near the upstream end of the crib. As this water was 8 to 10 degrees colder than the water at the bottom of the river, it was evident that a spring had been inclosed inside the crib, and its free flow to the river being prevented by the sheeting and the back filling, it had forced its way up, maintaining an opening for its discharge. The inclosed area was therefore allowed to fill again with water and two timber bulkheads 10 ft. apart were built across the interior of the crib 33 ft. from the upstream end. The space between these bulkheads was filled with concrete deposited directly in the water. When the resulting cross wall was completed, the area on its downstream side was again pumped out, and a layer of hand mixed gravel concrete 1 ft. thick was placed over the grouted rubble, this concrete being made of 1 bbl. of cement, 4.5 cu. ft. of sand and 20 cu. ft. of river gravel (containing about 18 per cent of sand). No attempt was made to repump the area on the upstream side of the cross wall, this area being brought up to the water surface with concrete deposited in the water. This concrete was machine-mixed and made of 1 bbl. of cement, 5 cu. ft. of sand and 27 cu. ft. of river gravel. This mixture was also used in completing the abutment. The interior timbers above the concrete were then removed and the superstructure begun.

The following conclusions were reached as the result of the experience gained in putting in this pier:

1st. The grout distributing boxes might with advantage, have been placed closer together to more easily enable the grout to fill all of the voids.

2d. The holes in the distributing boxes might, with advantage, have been larger and more numerous, the function of these boxes being in reality simply to maintain a vertical opening in the rubble, so that the inner box can be raised as the grout fills from below.

3d. The inner or grout feeding boxes might, with advantage, have had a smaller cross section, thus permitting the grout to reach the bottom in an unbroken intact column.

The cost of grouting this foundation crib was as follows:

Materials—	Total.	Per cu.yd. Grouted.
Cement, 721 bbls., at $2.74	$1,980	$2.26
Cement, hauled, 611 bbls., at $0.063	39	.04
Grout boxes, 6 M. ft B. M., at $13	78	.09
Fuel and oil	66	.08
Total	$2,163	$2.47
Labor—		
Mixing and placing, 595⅝ days	$1,033	$1.18
Grand total, 876 cu. yds. of stone grouted	$3,196	$3.65

The average work done per man per day was 1.47 cu. yds. of stone grouted.

Superstructure of Abutment.—The superstructure was started 5 ft. below the then water level (1 ft. below extreme low water), except at the upstream end of the river arm, where it was started at water level. The river face of the abutment is 20 ft. long on top and 132 ft. at the base, the face being battered not stepped. The stem is a core wall running 36 ft. into the bank, with embankments on both sides supported by the river arms, which are designed as surcharged retaining walls, and have a bottom thickness of one-half the height and a top thickness of 4 ft.

The land side of the river arms and the downstream side of the stem are stepped, but the other sides are vertical. The crest of the dam is opposite the middle of the top of the abutment. The river arm of the abutment was prolonged downstream at an angle of about 30 degrees by a 200 ft. rubble filled protection crib founded on gravel 16 ft. below water level and having a top elevation of 8 ft. above extreme low water. Its object is to form a footing for the paving and protect it from direct cutting and eddy attack. The bank was graded and paved for 450 ft. below the abutment and also for 100 ft. above it. A corner crib built to the level of the apron was constructed in the angle between the dam and the lower river arm of the abutment to prevent the latter from being undermined by the washing out of the 3 ft. of gravel above the boulders. The top of the new abutment is 14 ft. higher than the crest of the dam, or 12 ft. higher than the first abutment built, and its stem enters the bank 36 ft. instead of 8 ft.

The cost of the various items of work in connection with the construction of the superstructure of the abutment was as follows:

Concrete in Superstructure

Material—	Unit Cost.	Total.	Per cu.yd. Concrete.
Cement, 1,479 bbls.	$2.70	$3,993	$3.41
Cement, hauled, 1,479 bbls.	.063	94	.08
Fuel and oil	....	135	.12
Forms, 29.6 M. ft. B. M.	13.32	395	.34
Nails, 2 kegs	2.55	5	....
Total		$1,623	$3.95
Labor—			
On superstructure, 1,379 days		$2,588	2.21
Grand total, 1,171 cu. yds. concrete		$7,211	$6.15

There was 12,340 cu. yds. of back-filling in connection with the abutment, including a levee, the cost of this work being as follows:

Material—	Total.	Per cu.yd.
Fuel and rent of wheel scrapers	$169	$0.014
Labor		
Filling (dredge and teams), 1,089⅝ days	4,804	.389
Grand total, 12,340 cu. yds	$4,973	$0.403

Grading the bank required 73⅜ labor days, the cost being $155.

The cost of paving the bank with riprap was as follows:

Material—	Unit Cost.	Total.	Per cu.yd.
Riprap, 693 cu. yds.	.74	$513	$0.74
Labor—			
Paving, 425 days		$835	1.20
Inspection of riprap, 8 days		15	.02
Total		$850	$1.96
Grand total, 693 cu. yds. placed		$1,363	$1.96

The amount of paving done per man per day was 1.6 cu. yds.

The cost of the corner crib previously mentioned as being constructed in the angle between the dam and the lower river arm of the abutment was as follows:

Material—	Unit Cost.	Total.	Per M. ft.
Lumber, pine, 40.7 M ft. B. M.	$10.58	$432	$10.58
Lumber, hauled, 40.7 M. ft. B. M.	1.25	50	1.25
Iron, 1,000 lbs	.02	20	.49
Labor—			
Excavating	2.02	17	.40
Framing and placing timbers, 40.7 M. ft. B. M.	5.83	238	5.83
Grand total		$757	$18.55

Each man framed and placed .322 M. ft. per day.

The crib was filled with riprap, the cost being:

	Unit cost.	Total.	Per cu. yd.
Riprap, 527 cu. yds., at	$.74	$389	$.74
Placing, 118⅜ days		223	.42
Total		$612	$1.16

Each man placed 4.45 cu. yds. of stone per day

Summary of New Abutment.

	Total.	Unit Cost.
Clearing	$2,997	....
Excavation, 23,738 cu. yds	2,656	.112
Foundation crib, 65.3 M. ft	2,884	44.14
Sheet piles and sheeting, 28.7 M. ft.	1,205	41.93
Filling crib with riprap, 876 cu. yds.	901	1.03
Grouting foundation crib, 876 cu. yds. grouted	3,196	3.65
Concrete, 1,171 cu. yds	7,211	6.15
Backfill, 12,340 cu. yds	4,973	.403
Grading bank	155	....
Paving bank, 693 cu. yds	1,363	1.96
Corner crib, 40.7 M. ft	757	18.55
Filling corner crib, 527 cu. yds.	612	1.16

200 ft. Protection Crib.—As stated previously, this was a rubble filled structure founded on gravel 16 ft. below water level and having a top elevation of 8 ft. above extreme low water. Its object is to form a footing for the paving and protect it from direct cutting and eddy attack. The cost of the items in this portion of the work was as follows:

Excavation.

	Total.	Per Cu. yd.
Oil and fuel	$118	$.068
Labor, 202⅞ days	431	.246
Total, 1,750 cu. yds.	$549	$.314

Building Crib.

Material:	Unit cost.	Total.	Per M. ft. in crib.
Pine, 52 M. ft., B. M.	$9.50	$494	$5.82
Old timber, 32.8 M. ft., B. M.	....	....	.....
Timber hauled, 37.7 M. ft., B. M.	1.25	47	.54
Iron, 5,730 lbs	.02	114	1.34
Iron hauled	....	7	.10
Miscellaneous materials	....	8	.10
Total cost of materials	....	$670	$7.90
Labor, 423⅞ days	9.31	790	9.31
Grand total, 84.8 M. ft	....	$1,460	.....

Work done per man per day, 200 ft. B. M., placed.

Filling:

	Unit cost.	Total.	Per Cu.yd.
Riprap, 1,617 cu. yds., at	$.74	$1,195	$.74
Labor, 349 days		635	.39
Grand total, 1,617 cu. yds. filling		$1,830	$1.13

Work done per man per day was 4.6 cu. yds. of filling.

In placing 4,000 cu. yds. of back-filling by dredge and teams, the labor time was 1136-8 days, and the cost $305, making the unit cost $0.076 per cubic yard.

Grading 200 lin. ft. of bank took a labor time of 34⅜ days, the cost being $62 or $0.31 per lineal foot.

The cost of paving the bank with riprap was as follows:

	Unit cost.	Total.	Per Cu.yd.
Riprap, 438 cu. yds.	$.74	$324	$.74
Labor, 203⅞ days	....	374	.85
Grand total, 438 cu. yds.		$698	$1.59

The average work done per man per day was 2.1 cu. yds. of riprap placed.

Summary for 200 ft. Protection Crib.

	Total.	Unit Cost
Excavation, 1,750 cu. yds	$549	$.314
Timber work, 84.8 M. ft	1,460	17.21
Filling, 1,617 cu. yds	1,830	1.13
Backfilling, 4,000 cu. yds.	305	.076
Grading bank, 200 lin. ft	62	.31
Paving bank, 438 cu. yds	698	1.59

450 ft. Bank Revetment.—This work included the construction of 200 brush mats, the grading of the bank and paving it with riprap, the cost of the various items being as follows:

Brush Mattress:	Unit Cost.	Total.	Per Square.
Wire, etc.		108	.54
Riprap, 336 cu. yds. at $.74		248	1.48
Cutting and loading brush, 289⅝ days		$531	$2.60
Weaving and sinking, 213⅝ days		387	1.98
Inspecting 336 cu. yds. riprap, 4 days		7	....
Total, 200 squares...		$1,281	$6.40

Work done per man per day was .93 squares wove and sunk.

Summary for 450 ft. bank revetment:

	Total.	Unit Cost.
Brush mattress, 200 squares	$1,281	$6.40
Grading bank, 450 lin. ft.	229	.51
Paving bank, 1,044 cu. yds.	1,000	.96

A total of 450 lin. ft. of bank was graded, the total labor time being 123 6-8 days at a cost of $229 or $0.51 per lineal foot. Each man graded 3.6 lin. ft. of bank per day.

The cost of paving the bank was as follows:

	Unit cost.	Total.	Per Cu.yd.
Riprap, 1,044 cu. yds.	$.74	$768	$ .74
Paving, 109⅞ days		206	.197
Inspection of riprap, 14 days		26	.024
Grand total, 1,044 cu. yds.		$1,000	$ .96

The work done per man per day was 8.42 cu. yds. of riprap placed.

Summarizing we get the following as the cost of the 450 ft. revetment.

Brush mattress	$1,281
Grading bank	229
Paving bank	1,000
Grand total, 450 lin. ft., at $5.58	$2,510

EXTENSION OF DAM NO. I.

In the extension the general design of the original dam as regards type, width of base, etc., was adhered to, except that a slope instead of a step dam was built. Before the extension was built the original dam was changed from a step to a slope dam, this portion of the work being described elsewhere in this article. The extension was built with a slope of 1 to 4. The slope timbers are in two lengths, 18 ft. and 16 ft., overlapping each other, and are of white oak 8 x 2-in. scantling spaced 1 in. apart to allow the water free access to the interior of the dam and also to relieve the sheathing of any stresses that might be produced by the suction of the overflowing water or by the head produced by leakage into the interior through the backing. The toe of the apron was strengthened for four longitudinal courses by an extra stringer, so that the top of the vertical face now opposes to any eddy attack from below, two 10 by 12-in. by 20 ft. white oak timbers, in lieu of one as in the original dam. This precaution was taken because during a freshet subsequent to the one that destroyed the abutment, the apron of the original dam was damaged, 83 ft. of it being lifted at the downstream end, the parting of the crib work being at 40 ins. below the elevation of the apron.

The main obstacle in the way of easily constructing the extension to the dam was the large amount of derrick stone that had been deposited around the exposed end of the old abutment to protect it and the great masses of concrete from the wrecked abutment, 128 ft. long, practically all of which was in the way. As it would have required the removal of at least 1,000 cu. yds of this obstruction to found the dam extension on a level bed, it was decided to remove the large derrick, stone and broken concrete above water, and to build the dam around the stone and concrete under water, fitting it as well as possible and anchoring the crib to the concrete with iron bolts wherever possible. The holes for these bolts were drilled at least 18 ins. deep, and after the split bolt had been driven down upon the wedge at the bottom, the holes were filled with cement grout, those below water, through pipes. The upper end of the bolt passed through a 10 by 10-in. timber and was fastened down with nut and washer, the bolts having been cut to the proper lengths.

The portion of the dam extension next to the old abutment was built first. It was 59 ft. long and was founded, much of it above water, on derrick stone and the ruins of the old abutment stem. For the next 70 ft. the dam extension rests partly on bed rock, scoured to 17½ ft. below adopted low water and partly on boulders and concrete debris from the old abutment stem. The remainder of the dam is on gravel and boulders 12 ft. below adopted low water, this being as deep as the dredge could dig, the stage of water during the construction of this portion of the dam being about 4 ft. above low water. After the first 59-ft. portion of the dam had been constructed, work progressed from the other end. While the foundation was being excavated by the dredge, two cribs, each 100 ft. long, were being built in the water about 600 ft. above the dam.

As soon as the cut next the abutment was finished, the first 100-ft. crib was floated into position and built up until the timber in the crib exceeded the average depth of water by about 2 ft. The crib was then carefully weighted with stone in such a manner as to keep it as nearly level as possible while settling. The rock was placed upon planks laid over alternate pens, every other pen being left open. After the crib had been weighted on the high points until it would sink no more, the open pens were filled almost full of rubble. The stone used in sinking the crib was then thrown into the nearly filled pens and the planks over the other pens removed and the timber work resumed. The closing crib was 70 ft. long and the bottom over which it was built varied from 5 to 21 ft. in depth, the variation being due to large pieces of the old concrete abutment. The crib was built to suit the bottom as nearly as possible, but as the largest mass of concrete was near the downstream wall of the dam, this wall had little support from interior timbers. To strengthen it a 20 by 65 ft. crib was sunk just below it. Between this crib and the old abutment closing the gap, another reinforcement crib, 20 by 42 ft. in size, was built for the same purpose. A third crib was built as a protection crib around the two exposed sides of the old abutment. This crib was L-shaped in plan, with arms 42 ft. and 46 ft. long, the latter overlapping the 20 by 42 ft. crib.

The crest, slope and apron timbers, were framed as far as possible in the yard before construction began; they were put on in alternate 10-ft. sections, thus completing the filled sections of the dam, except the sheeting of the upstream face, before the others. A slope dam being harder to build than a step dam and time being limited, this method was adopted as a precautionary measure, in order to reduce to a minimum the amount of carpenter work to be done after all the pens had been filled with stone. The upstream timbers were all laid and toe nailed, those over the filled pens were drift-bolted, and those over the empty ones then taken off and laid on the dam ready to be put back into their places as soon as the pens were filled. The downstream slope timbers and apron sticks not being intended to fit closely were not placed in position over the empty pens until they could be laid permanently. The timbers were delivered by barges and put in place on the dam faster than they could be drift-bolted, largely by means of two very simple devices called "raising boats." The "raising boat" was merely a 2 by 10 by 40 ft. decked barge fitted with a crab, an inclined fixed boom with a sheave at its upper end, and a piece of ¾-in. or 1-in. manila rope ending in a pair of timber hooks. The boom, of about 6 by 8-in. scantling, is supported by an A frame near the bow of the boat and securely fastened to the deck near the stern. It projects about 7 ft. beyond the bow of the boat and reaches to a height of about 12 ft. above water. One of these boats was used above the dam and one below. They proved very useful, could go where the derrick boats could not go, and could have handled the timber for the entire dam if necessary, though derrick boats, owing to their longer reach, were more useful in placing the interior timbers. After the pens had all been filled with rubble and the framing completed this extension to the dam was quickly sheeted on the upstream side with double lap 2 by 12-in. planks driven by hand mauls to the bowlders, sheet piling not being necessary in this case to prevent leakage and scour under the dam, as, considering the depth of foundation, the sheeting and back filling is ample protection.

In placing the back filling a side-dump scow holding about 60 cu. yds. was used, but owing to its limited capacity and to the necessity for quick work, as the pool was filling, decked flatboats 4 ft. by 20 ft. by 100 ft. were also employed, the puddle on them being unloaded with shovels and with scrapers. The scrapers were of two kinds, first the common steel drag scrapers, which, proving less efficient, were discarded later for flat wooden scrapers, crude affairs consisting merely of a piece of 3 by 12-in. plank 4 ft. long beveled at the lower edge, which was fitted with two wheelbarrow handles as guides and a drag scraper bail for the pulling rope. One barge of 40 cu. yds. capacity was unloaded in one hour with two of these wooden scrapers, using eight men on the barge and four on the derrick boat below the dam. The derrick engine had two winch heads, both of which were used.

The cost of building the extension was as follows:

Excavation.

Fuel and oil	$ 384
Labor, 298 days	730
Total	$1,114

Timber Work.

Materials:	Unit cost.	Total.	Per M. ft. Frame and Placed.
Pine, 384.4 M. ft., B. M.	$9.66	$3,717	$ 6.17
Oak, 217.8 M. ft., B. M.	15.33	3,332	5.53
Timber hauled, 495.3 M. ft., B. M.	1.25	619	1.03
Iron, etc., 30,958 lbs.	.022	717	1.19
Oil and fuel		342	.57
Miscellaneous		670	1.11
Labor:			
Framing and placing, 2,416 6/8 days		4,590	7.62
Total timber work, 602.2 M. ft.		$13,988	$23.22

Work done per man per day was 249 ft. B. M., framed and placed.

Filling.

	Unit cost.	Total.	Per Cu.yd.
Riprap, 8,681 cu. yds.	$.74	$6,417	$ .74
Filling, 2,137 2/8 days	....	4,008	.46
Inspection of riprap, 116 days	....	202	.02
Total, 8,681 cu. yds.		$10,627	$1.22

Puddling:

	Unit Cost.	Total.	Per Cu.yd.
Oils and fuels	....	$ 567	$.034
Labor, 1,660 6/8 days	....	3,343	.202
Total, 16,550 cu. yds.		$3,910	$.236

Protecting apron and cribs with derrick stone:

	Unit Cost.	Total.	Per Cu.yd.
Royalty on stone, 642 cu. yds.	$.10	$ 64	$ .10
Quarrying and placing, 415⅜ days	....	768	1.19
Total, 642 cu. yds.		832	$1.29

Work done per man per day was 1.54 cu. yds. quarried and placed.

Summarizing the cost of the extension of the dam was as follows:

	Total.	Unit Cost
Excavation	$ 1,115	.....
Timber work, 602.2 M. ft.	13,988	$23.22
Filling, 8,680 cu. yds.	10,626	1.22
Puddling, 16,650 cu. yds.	3,911	.236
Protecting apron, etc., 642 cu. yds.	832	1.29
Total	$30,472	

The extension was 336½ ft. long and cost $90.36 per lineal foot.

MISCELLANEOUS WORK.

In connection with the construction of Lock and Dam No. 1 the following additional work was done:

Old Abutment Protection Crib.

Excavation:			
Labor, 75⅛ days		$146	

Construction:

Material.	Unit cost.	Total.	Per Cu. yd. Placed.
Pine, 57.2 M. ft.	$10.67	$ 610	$ .90
Pine, hauling 57.2 M. ft.	1.25	71	.10
Iron, 4,260 lbs.	.....	85	.12
Riprap, 677 cu. yds.	.74	500	.74
Total material	.....	$1,266	$1.86
Labor:			
Framing and placing timber, 57.2 M. ft.	$3.68	$ 211	$ .31
Filling with stone, 677 cu. yds.	.34	230	.34
Total labor		441	.63
Grand total		$1,707	$2.41

The work done per man per day was 49 ft. of timber framed and placed; 5.4 cu. yds. of riprap was placed per day per man.

Apron Crib.

Timber Work:

Material.	Unit Cost.	Total.	Per M. ft.
Pine, 16.7 M. ft.	$10.09	$ 169	$10.09
Pine, hauled, 16.7 M. ft.	1.24	21	1.24
Labor, 128 2/8 days	14.04	235	14.04
Grand total			$25.37

Filling:

Material.	Unit cost.	Total.	Per Cu. yd. Filling.
Riprap, 683 cu. yds.	$ .74	$ 505	$ .74
Miscellaneous	.....	42	.06
Total materials		$ 547	$0.81
Labor:			
Filling, 144⅛ days	....	264	.39
Inspection of riprap, 8 days	.....	15	.02
Total labor		$ 279	$.041
Grand total, 683 yds. filling		$ 826	$1.22
Total cost of crib (683 cu. yds.)		$1,251	$1.83

Lockhouse.

Material:	Unit cost.	Total.	Per cent of Cost.
Hardware	.....	$ 100	3.02
Stone	.....	310	9.36
Doors, etc.	.....	606	18.34
Lumber, 5.4 M. ft.	$12.13	90	2.72
Oils and paints	.....	61	1.81
Roofing paper	.....	35	1.05
Lime, etc., 76.5 bbls.	.901	69	2.08
Cement and hair	.....	7	.2
Tin work	.....	48	1.45
Screens, etc.	.....	22	.7
Brick, 5.2 M.	8.00	42	1.26
Miscellaneous	.....	24	.8
Total materials		$1,414	42.7
Labor:			
Excavation, 94⅜ days	.....	$ 180	5.43
Laying stone, 129 cu. yds.	$ 3.47	449	14.47
Laying brick, 5.2 M.	11.27	59	1.78
Carpenter, 324 4/8 days	.....	819	24.74
*Plastering, 853 sq. yds.	.16	136	4.11
Plasterers' helpers	.16	138	4.11
Painting and plumbing	.....	71	2.14
Miscellaneous	.....	44	1.26
Total labor		$1,896	57.3
Grand total		$3,310	

Cistern.

Brick, 2 M.	$8	$16
Cement, 1 bbl.	3	3
Lime, 4 bbls.	.89	3.56
Total material		$22.56
Labor, 31 days		65.86
Grand total		$88.42

Highwater Sills.

Dam at B 5:

Material:	Unit cost.	Total.	Per Cu.yd.
Riprap, 247.4 cu. yds.	$ .77	$ 192	$ .77
Labor:			
Cutting and placing brick, 11 days	.....	22	.....
Hauling brick, 4 days	....	15	.....
Weighing stone, 247.4 cu. yds.	.022	5	.....
Laying stone	....	30	.....
Total labor		$ 72	$ .28
Grand total (247.4 cu. yds.)		$ 264	$1.05

Sill at Cl + 50.

Material:	Unit cost.	Total.	Per cu.yd.
Riprap, 149 cu. yds.	$ .70	$ 104	$ .70
Labor:			
Total labor		$ 50	$3.35
Grand total		$ 154	$1.03

1,000 ft. sill.

Material:	Unit cost.	Total.	Per lin. ft. of sill.
Riprap, 1,665.6 cu. yds.	$ .65	$1,084	$1.18
Crushed stone, 329 cu. yds., no charge.			
Labor:			
Cutting and placing brush	.....	$ 91	$.091
Hauling brush	.....	138	.138
Weighing stone, 1,666 cu. yds.	$ .012	20	.020
Laying riprap, 1,666 cu. yds.	.267	447	.447
Loading crushed stone, 329 cu. yds.	.256	84	.084
Towing crushed stone, 329 cu. yds.	.149	49	.049
Unloading crushed stone, 329 cu. yds.	.269	88	.088
Hauling crushed stone, 329 cu. yds.	.141	47	.047
Placing crushed stone, 329 cu. yds.	.126	41	.041
Total labor		$1,006	$1.00
Grand total (1,000 lin. ft. of sill)		$2,090	$2.09

Some of the labor items can be still further summarized, as follows:

	Work Done. cu. yds.	Labor Time in Days.	Work Done Per Man Per day. cu. yds.
Laying riprap	1,666	250 6/8	6.64
Loading crushed stone	329	48 6/8	6.54
Towing crushed stone	329	20	16.45
Unloading crushed stone	329	46	7.18
Hauling crushed stone	329	13⅛	25.06
Placing crushed stone	329	20 4/8	16

Grading and Fencing Reservation.

Labor:

Material:	Unit cost.	Total.
Lumber, 4.2 M. ft.	$12.62	$52.63
Nails, 1 keg	2.25	2.25
Cedar posts, 140	.10	14.00
Total (1,060 lin. ft.)	.65	$68.88
Grading and clearing	.....	$ 330
Fencing	.....	166
Total		$ 496
Grand total		$ 565

Marine Ways.

Material:	Unit cost.	Total.
Lumber, pine, 7.5 M. ft.	$14.37	$ 108
Lumber, oak, 15. M. ft.	11.51	285
Iron, etc., 1,509 lbs.	.026	41
Riprap, 180 cu. yds.	.74	133
Total materials		$ 567
Labor:		
Construction, 33.5 M. ft.	$11.40	$ 268
Laying riprap, 180 cu. yds.	.854	154
Total labor		$ 422
Grand total		$ 989

Rebuilding Warehouse and Incline.

Material:	Unit cost.	Total.
Lumber, 5.9 M. ft.	$13.39	$ 80
Shingles and nails	.....	103
Total materials		$ 183
Labor, 181⅝ days	.....	$ 363
Grand total		$ 546

GENERAL SUMMARY.

The total field expenses for the work amounted to $262,628.47, divided up as follows:

	Labor.	Materials.	Total.
Lock	$ 42,928.84	$ 40,956.26	$ 83,885.10
Old Abutment	6,914.84	6,481.19	13,396.03
New Abutment	15,061.23	10,873.01	25,934.24
200 ft. protection crib	2,597.02	2,307.84	4,904.86
450 ft. bank revetment	1,386.34	1,124.72	2,511.06
Old main dam	16,663.48	19,499.78	36,163.26
New dam extension	13,641.84	16,830.24	30,472.08
Miscellaneous items	5,613.38	5,774.16	11,387.54
Apportionable expenses	33,589.76	20,384.54	53,974.30
Total	$138,396.73	$124,231.74	$262,628.47

Of the $262,628.47 spent in the field, $208,654.17 was for permanent construction and $53,974.30 was for the following items which constitute 25.87 per cent of the sum spent on permanent work:

	Amount.	Per cent of $208,654.17
Care of property	$ 5,388.84	2.59
Floating plant	18,851.54	9.04
Bank plant	7,578.90	3.63
Temporary buildings	5,039.59	2.41
Plant purchased	6,392.82	3.06
Transfer of fleet from Lock 2 to Lock 1	364.75	.18
Surveys, plans, etc.	7,660.67	3.67
Miscellaneous items	2,522.65	1.21
Inspection trip to Buffalo	164.54	.08
Total	$53,974.30	25.87
Expenses of Little Rock, Ark., office, etc.	$16,252.60	7.78
Total spent outside of permanent work	$70,226.90	33.65

The total cost to the appropriation was as follows:

Permanent construction	$208,654.17
Apportionable expenses	53,974.30
Little Rock office	16,252.60
Total	$278,881.07

The total length of telephone lines in Switzerland is 10,548 miles.

Methods and Costs; Some Old; Some New.

Dust Laying With Calcium Chloride.—During the past winter several of the business streets of St. Paul, Minn., were sprinkled to keep down the dust, which the absence of snow made very disagreeable. Two pounds of calcium chloride to a gallon of water were used in the ordinary city sprinkling cart. The chemical was melted by steam and applied as is water. Experiments were tried before the first snow fall, and the sprinkled streets remained moist the four days preceding the snow. Steam for melting the calcium chloride was obtained from the boiler of a steam roller belonging to the city. At 40 lbs. pressure it took 20 minutes to melt the chemical. Steam from a heating company at 4 lbs. pressure took considerable more time. It cost about $12 for one tank of the mixture, which covered 15 blocks.

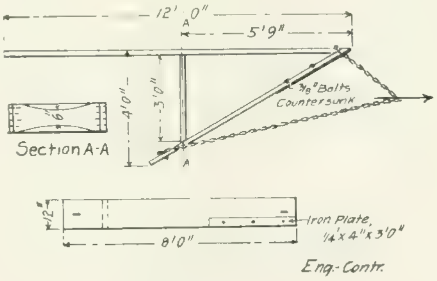
Macadam Road Foundation.—The following method of constructing the foundation of macadam roads has been used with excellent results by Mr. Thomas Aitken, the well known English Road Engineer, in building many miles of new roads. The rough material, after being placed on the foundation level of the road, is broken into cubes of from 3 ins. to 4 ins. in diameter to the requisite depth, generally 9 ins. at the center, and 7 ins. at the sides. This coating is then consolidated by steam rolling, and a 2-in. layer of sand spread over the surface partly to fill the interstices and partly to form a cushion for the top metal, or wearing surface. The quality of the stones forming the foundation of a road should be of a good and hard description, and not liable to be affected by frost or heavy-wheel traffic.

Cost Data on Maintaining Earth Roads by Dragging.—In a recently issued Farmers' Bulletin, Mr. D. Ward King gives some data on the cost of maintenance of earth roads by dragging. He states that the most elaborate form of split log drag will cost but a few dollars for material and labor, while one man and team can operate it successfully under all usual conditions. Mr. King gives the following figures as showing the cost of maintaining ordinary country roads per mile per year without a drag. They were obtained in Kansas by Prof. W. C. Hoad, of the University of Kansas, in 1906, and were taken from the official records of the counties:

Crawford County	$52
Douglas County	38
Franklin County	34
Johnson County	48
Neosho County	40
Saline County	43

The average cost is $42.50 per mile per year, and Mr. King states that it may safely be said that the cost of dragging would be trifling in comparison. In the Report of Highway Commissioner of Maine in 1906 it is stated that the least expense per mile for dragging was about $1.50; the greatest a little over $6; the average expense per mile for 5½ miles a little less than $3. One township in Iowa experimented with the drag on 28 miles of highway for a year. The township paid for the making of the drags and hired men to use them. The total expense, including the original cost of the drags, for the year averaged $2.40 per mile. A neighborhood of farmers in Ray County, Mo., employed one of their number to drag a 5-mile stretch. He received compensation at the rate of $3 per day. When the end of the year came and a settlement was made, the cost for the year was found to be $1.66 per mile. The road is a tough clay. Prof. William Robertson, of the Minnesota Agricultural Station, after a year's experience in dragging a main road made entirely of gumbo without any sand or gravel, and which during the past year has shown no defects either by rutting or development of soft places, fixes the cost of the work at not to exceed $5 per mile.

Ditch Cleaner for Use on Earth Roads.—The accompanying cut shows a convenient device for cleaning ditches along earth roads. It consists of a guide plank 2 in. x 12 in. x 12 ft., and a mold board 2 in. x 12 in. x 8 ft. These are braced with a crosspiece 3 ft. long as shown in the cut. The mold board should be shod with an iron plate ¼ in. x 4 in. x 3 ft., held in place with ⅜ in. bolts countersunk. The cross brace should be hollowed 3 ins. on each side at the middle, the hollowing to begin not less than 4 ins. from each end, in order that its bearing against the guide and mold board planks shall not be shortened, nor the nailing space decreased. This is done to prevent earth from heaping up in front of the brace. A light platform is needed to make the use of the ditcher safe. The hitch is made as shown in the cut, the short side of the chain being about 2 ft. 3 ins. in length and the long side 8 ft. 3 ins. The chain is made to pass over the mold board, so that it may clear itself more readily. Two or three horses, according to the difficulty of the particular condition, are necessary to clear a ditch. To secure the best service from the ditcher, a weight of about 200 lbs. should be placed over the front end. The essential thing to be gained is to have the ditcher maintain a smooth, even surface on the bottom of the ditch. This requires that soft, muddy holes be passed over lightly and hard, high places be reduced. This result is obtained if the driver shifts his weight forward or backward as a high point or a mud hole is approached. If the driver shifts his weight forward, the point of the ditcher is driven into the ground. If he moves back, the pressure on the forward end is relieved and the pull on the chain tends to raise it. Besides clearing the ditch, the ditcher assists in preserving the slope from the side of the road to the bottom of the ditch. This keeps the road safe from possible accident to traffic from ditches with too abrupt slopes. The device is described in a recently issued Farmers' Bulletin of the U. S. Department of Agriculture, and the matter in this note has been taken from that bulletin.



Ditch Cleaner.

Cost of Concrete Floor Lining for a Tunnel.—The following data relating to the lining of 749 lin. ft. of the Gunnison Tunnel, Uncompahgre Project, were given in the April Bulletin of the U. S. Reclamation Service, under whose supervision the work is being done. The tunnel has a bottom width of 10 ft. and the average floor thickness is 6 ft. The data are for work done in the month of September, 1907. The cost of the work was as follows:

	Total.	Cost Per C. Yd.	Cost Per L. Ft.
Preparing floor for lining:			
Superintendence	$ 34.00	$0.20	$0.05
Handling material	$118.56	.71	.16
Hauling material	33.60	.20	.04
Total	$186.16	$1.11	$0.25
Placing floor lining:			
Superintendence	$ 36.25	$0.21	$0.05
Mixing and hauling concrete	92.00	.55	.12
Plac'g grade boards	31.92	.19	.04
Placing concrete	101.84	.61	.14
Cement	756.00	4.50	1.01
Sand and gravel	148.68	.88	.20
Total	$1,166.69	$6.94	$1.56
Grand total	$1,352.85	$8.05	$1.81

Each cubic yard of concrete was mixed in the proportion of 6 sacks of cement to 12 cu. ft. of sand and 26 cu. ft. of gravel. The wages paid per eight hour day were as follows:

Concrete foreman	$5.00
General foreman	4.00
Laborers	3.04
Motormen	3.04
Brakemen	2.56

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review, timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are: First, to inform civil engineers and contractors of the articles and papers of merit, that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING-CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

American Architect (Am. Arch.), New York, N. Y.; w; 7x10 in.; 15 cts.
American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.
American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y.; m; 7x10 in.; 20 cts.
American Engineer and R. R. Journal (Am. Engr. & R. R. Jl.), York, N. Y.; m; 7x10 in.; 20 cts.
American Gas Light Journal (Am. G. L. Jl.), New York, N. Y.; w; 10x13 in.; 10 cts.
American Machinist (Am. Mchst.), New York; w; 7x10 in.; 15 cts.
Annales des Ponts et Chaussees (An. P. & C.), Paris, France; m.
Architects and Builders Journal (Arch. & Bldrs. Jl.), Baltimore, Md.; m; 9x12 in.; 20 cts.
Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.
Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.
Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.
Bulletin International Railway Congress (Bul. Int. Ry. Cong.), Brussels; m; 50 cts.
Bulletin U. S. Geological Survey (Bul. Geo. Surv.), Washington, D. C., 4x7 in.
Bulletin U. S. Department of Agriculture (Bul. Dept. Agr.), Washington, D. C.; 4x7 in.
Bulletins Railway Engineering & Maintenance of Way Association (Bul. Am. Ry. Eng. & M. of W. Assoc.).
California Journal of Technology (Cal. Jl. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.
Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x10 in.; 20 cts.
Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.
Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.
Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.
Canadian Mining Journal (Can. Min. Jl.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.
Canadian Municipal Journal (Can. Mun. Jl.), Montreal, Que.; m; 6¾x10 in.; 10 cts.
Carpentry and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.
Cassier's Magazine (Cas. Mag.), New York, N. Y.; m; 5x8 in.; 25 cts.
Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.
Cement Age (Cem. Age), New York, N. Y.; m: 4x7 in.; 10 cts.
Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.
Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.
Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.
Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.
Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.
Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.
Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.
Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.
Concrete and Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.
Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.
Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.
Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.
Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.
Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.
Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.
Electric Railway Review (Elec. Ry. Rev.), Chicago, Ill.; w; 7x10 in.; 20 cts.
Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.
Electric Traction Weekly (Elec. Trac. Wkly.), Cleveland, O.; w; 7x10 in.; 10 cts.
Engineer (Engr. Lon.), London, England; w; 4x11 in.
Engineer, (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.
Engineering (Eng.), London, England; w; 8x11 in.
Engineering Digest (Eng. Dig.), New York, N. Y.; m; 5x8 in.; 20 cts.
Engineering-Contracting (Eng.-Contr.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Engineering and Mining Journal (Eng. & Min. Jl.), New York, N. Y.; w; 7x10 in.; 15 cts.
Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.
Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.
Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.
Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.
Le Genie Civil, Paris, France; w.
Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.
Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.
Industrial World (Ind. Wld.), Pittsburg, Pa.; w; 7x10 in.; 10 cts.
Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; $1.
Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.
Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.
Iron Trade Review (Iron T. Rev.). Cleveland, O.; w; 7x10 in.; 15 cts.
Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.
Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.
Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.
Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.
Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.
Journal of Electricity, Power and Gas (Jl. Elec., P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.
Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.
Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.
Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.
Mines and Minerals (Mi. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.
Mining and Scientific Press. (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.
Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.
Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.
Modern Machinery (Mod. Mchy.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Municipal Journal and Engineer (Mun. Jl. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.
Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.
Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.
Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w; 9x11 in.; 15 cts.
Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.
The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 ins., 15 cts.
Power, New York, N. Y.; m; 7x10 in.; 20 cts.
Proceedings American Institute of Electrical Engineers (Proc. Am. I. of E. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings American Society of Civil Engineers (Proc. Am. Soc. C. E.), New York, N. Y.; m; 4x7 in.; 75 cts.
Proceedings American Society of Mechanical Engineers (Proc. Am. Soc. M. E.), New York, N. Y.; m; 4x7 in.; 50 cts.
Proceedings Engineers' Club of Philadelphia (Proc. Engrs.' Club, Phila.), Philadelphia; qr.; 4x7 in.; 25 cts.
Proceedings Canadian Society of Civil Engineers (Proc. Can. Soc. C. E.), Montreal; m; 4x7 in.; 50 cts.
Railroad Gazette (R. R. Gaz.), New York; w; 8x11 in.; 15 cts.
Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.
Railway Age (Ry. Age), Chicago, Ill.; w; 7x10 in.; 10 cts.
Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.
Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.
Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.
Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.
Roadmaster and Foreman (Rd. & For.), Chicago; 7x-0 in.; 10 cts.
Rock Products (Rk. Prod.), Chicago, Ill.; bi-w.; 9x11 in.; 10 cts.
Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.
School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr.; 4x7 in.; 30 cts.
Schweizerische Bauzeitung, Zurich; w.
Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.
Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.
Sibley Journal of Engineering (Sib. Jl. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.
Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.
Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.
Street Railway Journal (St. Ry. Jl.), New York, N. Y.; w; 7x10 in.; 10 cts.
Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.
The Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.
Waterproofing (W. P.), New York, N. Y.; m; 5x8 in.; 10 cts.
Zeitschrift d. Oest. Ing. u Arch. Ver. Vienna; w.
Zeitschrift d. Ver Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

A Concrete Block Track for Highways. Eng. Rec., May 2, 1908, ½ p.

A letter from H. H. Dickson to the editor describing a method of building two tracks for the wheels of a wagon to run upon, of concrete blocks, leaving the rest of the road unimproved. Such a road has been tried in Florida, Mr. Dickson states, with success.

Experiments With Dust Preventives on a Road at Wayland, Mass. Eng. Rec., May 2, 1908, 3 pp.

An account of a series of experiments made by the Office of Public Roads of the Department of Agriculture, to test various materials as preventives of dust. Over a dozen preparations were tried and the result obtained recorded.

Cost of Operating the Brooklyn Asphalt Repair Plant and of Laying the Pavement. Eng. Rec., April 11, 1908, 1 p.

Gives the cost of erecting this municipal plant for repair work, the cost of operating it and the cost of the asphalt delivered on the street.

Split Log Road Drags in Ontario. Eng. News, April 2, 1908, ½ p.

Gives recommendations for construction and use of split log road drags based on competition carried out in Ontario in 1907.

Cost of Brick Pavements and Cement Mortar Curbs at Centerville, Ia. By M. G. Hall, Eng. News, April 2, 1908, 2 pp.

Gives in tabular form cost of pavement on five jobs itemized for concrete foundation, for brick and laying and for cement filler; also itemized cost of cement curbs for nine jobs. The figures are valuable.

Progress Reports of Experiments with Dust Preventives. Public Roads Circular No. 89, Dept. of Agriculture; 26 pp.

Gives records of experiments in different sections of the country on preventing dust on roads and streets with various preparations. Crude tar and tar products, oils of different kinds, calcium chloride, asphalt and other dust preventives. Some cost data are given.

The Use of the Split Log Drag on Earth Roads. By D. Ward King. Farmers' Bulletin No. 321, Department of Agriculture; 14 pp.

Describes and illustrates this road tool giving drawings of it with dimensions. Tells of its use and the beneficial results obtained, and gives some costs of draging roads.

The Paris International Road Congress. Good Roads Mag., April, 1908; 1½ pp.

An international congress is to be held in Paris, France, in October, to consider the management of roads in their adaptation to motor traffic. The article is a translation of the general regulation of the congress.

Tar Spraying in Bristol. The Surveyor, March 27, 1908; ½ p.

Describes the results obtained from tar spraying various roads in Bristol, England.

Types of Drains, Culverts and Bridges Advocated by the State Highway Department of Pennsylvania. By G. A. Flink, Good Roads Mag., April, 1908; 4½ pp.

Descriptions of the standard types of concrete culverts and bridges of the Pennsylvania State Highway Department. Numerous drawings of the structures are shown.

Practical Suggestions on Highway Improvements. Good Roads Mag., April, 1908; 3 pp.

General article on the improvement of country roads. The matter is taken from the 12th Annual Report on Highway Improvements in the Province of Ontario.

Road Problems in England. By H. Howard Humphreys. Good Roads Mag., April, 1908; 2½ pp.

A paper read before the English Society of Road Traction Engines. The paper treats in a general way of road maintenance.

A Street Cleaning Automobile. Mun. Eng. Mag., May, 1908, 1 p.

A brief description of the electrically propelled combined sprinkling and cleaning cart used by the Street Cleaning Department of Berlin, Germany.

Kentucky Rock Asphalt Macadam. Mun. Eng. Mag., May, 1908; 1 p.

Describes briefly a form of macadam roadway constructed of crushed stone and Kentucky rock asphalt.

SEWERS.

A Large Double Barrel Sewer Built Across a Salt Marsh. Eng. Rec., April 4, 1908, 3 pp.

A description of a reinforced concrete sewer, 21x8 ft., built across a marsh in the Borough of Bronx, New York. Details of the work, such as pile driving, excavation, concreting and other features are described.

The Canal Street Tunnel Sewer, New York City. Eng. Rec., April 18, 1908; 2½ pp.

The sewer is located either under or adjoining the foundations of 5 to 7-story brick and steel buildings and is built in tunnel by a variation of the shield method, details of which are described, and method of timbering is illustrated.

Removing Iron From Ground Waters. Mun. Jl. & Engr., April 29, 1908; ½ p.

Describes the method employed at Dover, N. H., for removing iron from the ground water supply of the city.

Sewage Disposal at Pittsfield. Mun. Jl. & Engrs., April 8, 1908; 1 p.

Describes in a general way the sewage disposal system of Pittsfield, Mass. A device to avoid increasing the heights of the vent pipes to prevent an overflow from them is illustrated and described.

Bacteria in House Drain Pipes. By Dr. F. J. H. Coutts. Mun. Eng. Mag., May, 1908; 3 pp.

The article treats of sewer ventilation and includes a description of the experiments of Major W. H. Horrocks, on the carriage of bacteria by the air passing through drains.

Phenomena of the Crushing of Sewer Conduits. By James N. Hazlehurst. Mun. Eng. Mag., May, 1908; 3 pp.

The author describes conditions under which sewer pipe has failed, and gives reasons for the failure. The article is extracted from a paper read before the American Society of Municipal Improvements.

GARBAGE AND CITY WASTES DISPOSAL.

Report on Street Cleaning and Waste Disposal, New York City. Eng. News, April 23, 1908, 2⅔ pp.

Extracts from a report of a commission of engineers on street cleaning and waste disposal in New York City. Tables of estimated costs of street cleaning by various methods are given together with statements of weight and character of street dirt.

City Wastes Disposal and Street Cleaning. By Paul Hansen. The Surveyor, March 27, 1908; 3 pp.

This article by the assistant engineer of the State Board of Health of Ohio treats briefly of the various methods of waste disposal and street cleaning employed in the United States.

Rubbish Incineration in New York. Mun. Jl. & Engr., April 15, 1908; 2½ pp.

Gives details of the work of the Street Cleaning Department of New York City in disposing of rubbish. Data on the composition and weight of rubbish are given.

Seattle Refuse Destruction. By W. F. Morse. Mun. Jl. & Engr., April 29, 1908; 2½ pp.

Describes the refuse destructor of the city of Seattle, Wash. The destructor is of the Meldrum type and has been in service since January. It is the first destructor of English design to be erected and put in operation in the United States.

Get Our Prices
And Latest Catalogues
Before Buying Books On Any
Engineering or Contracting Subject

Write us To-day

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

715 Illustrations; 70 Tables
and 906 Pages
Shows the size of Mr. Homer A. Reid's book.

"Concrete and Reinforced
Concrete Construction"

Price, $5 net, postpaid

This book contains more text pages, more drawings, more tables of text data, more ORIGINAL matter, than any other book or books ever published on this subject.

WRITE FOR 16-PAGE TABLE
OF CONTENTS

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

SUBURBAN RAILWAY SURVEYS.

This important subject is treated in a 25-page chapter of Lavis' treatise on "Railroad Location Surveys and Estimates." Mr. Lavis writes from personal experience on suburban rapid transit location, and his discussion of this subject can not fail to be of value to every civil engineer who is interested in this important branch of railway work. The other chapters of this book are also written from an experience in railway location not only in the East, far West and South, but in the tropics. Although it is a new book, several engineering colleges have adopted it as a text-book, and a thousand practicing railway engineers have purchased it. No book of its kind has received such favorable reviews by railway papers and the technical press generally. "Railroad Location Surveys and Estimates," by F. Lavis, M. Am. Soc. C. E., is a 270-page book, price, $3 net, postpaid.

THE MYRON C. CLARK PUBLISHING CO.,
355 Dearborn St., Chicago.

Over 10,000 Copies
OF GILLETTE'S HANDBOOK OF
COST DATA

were sold during the first 22 months. This book is invaluable to any person interested in construction work of any kind.

Flexible leather, gilt edges, 622 pages, illustrated; $4.00 net postpaid.

24-page circular, showing contents and sample pages, also catalogs giving information concerning all classes of books for contractors and engineers will be mailed

FREE

Tell us in what you are interested.

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

WATER-WORKS AND HYDRAULICS.

The Action of Water on Pipes. By Freeland Howe, Jr., Jl. N. E. W. W. Assoc., 13 pp.

The causes of corrosion of water pipe by water are discussed and how to prevent it.

Indian Creek Water Supply System. By J. W. Ledoux. Eng. Rec., April 11, 1908, 2½ pp.

A description of a water supply system built by the Pennsylvania R. R. for obtaining water for their locomotives in Western Pennsylvania. A description is given of the construction work as well as the distributing system. In all 12 reservoirs were built and 135 miles of pipe laid.

Some Phases of Hydraulics. By Gardner S. Williams. The Michigan Technic, February, 1908; 8 pp.

A synopsis of the history of the experiments made in hydraulics on the flow of water is given. Then formulas for the flow of water in pipes, in open channels, and over rivers are given and discussed.

Method and Cost of Laying a Submerged 12-in. Water Main. By J. Causley. Eng.-Contr., April 22, 1908; 2⅔ pp.

Describes the method employed for laying a 12-in. cast iron pipe line across the narrows at Vancouver, B. C., where the depth of water is from 66 to 75 ft., and has an 8-knot current. Drawings are given of the joint details and of the apparatus used and the cost of the work is itemized.

Hydro-Electric Plant of the Liskeard Light, Heat and Power Co., Ltd. By D. Sinclair. Can. Engr., May 1, 1908; 2½ pp.

Describes the construction of a power development consisting of a dam, steel pipe line, a power house containing one hydraulic unit direct connected to the generator, and a 3-phase transmission line. The dam is of timber crib construction filled with rock and gravel.

Ice Troubles in Hydraulic Power Work and Methods of Overcoming Them. By John Murphy. Can. Engr., May 1, 1908; 4½ pp.

Various methods of preventing Frazil formation are given in this article.

Masonry Dam Formulas. By Orrin L. Brodie. Sch. Min. Quart, April, 1908; 30 pp.

A discussion of the formulas used in the designing of high masonry dams for the Board of Water Supply of New York. They are of two kinds, formulas for designing and formulas for investigating a given design or cross sections. The nomenclature used in the department is also given.

Rain and Run-off Near San Francisco, California. By C. E. Grunsky. Proc. Am. Soc. C. E., April, 1908; 20 pp.

A record of the rainfall and run-off in the water shed in which are located the three reservoirs that supply San Francisco with water is given and discussed. These records extend back to 1865. A fact that has come to the attention of those who are familiar with rainfall records in California, is that where the rainfall exceeds 10 in. per annum the maximum annual rain at any point is twice the normal, and the minimum is two-fifths of the normal. This relation of the maximum and minimum to the normal is of great value in the discussion of water production.

IRRIGATION AND DRAINAGE.

Some Economic Advantages of Large Size Drain Tile. By F. M. Okey. Eng.-Contr., April 29, 1908; 2 pp.

An interesting comparison of the relative efficiency of large and small size drain tile on the basis of economy. The author concludes that the larger sizes have an economic value relative to cost. The paper is instructive and useful.

RIVERS, HARBORS AND CANALS.

Dredging Equipment on the Panama Canal. By F. B. Maltby. Proc. Engrs. Club, Philadelphia; January, 1908; 9 pp.

Describes briefly the character of the dredging plant at work on the Panama Canal and gives general figures of cost. An interesting article for general information.

The Concrete Sea Wall at Cebu, Philippine Islands. By H. F. Cameron. Eng. Rec., April 25, 1908, 2 pp.

A description of the design of the sea wall and of the methods of construction, showing the difficulties encountered in doing work in the Philippines. The article is of use to those undertaking work in the Orient.

RAILWAYS.

Itemized Cost of the Northern Pacific Railway System as Estimated by Its Chief Engineer. Eng.-Contr., April 15, 1908; 2⅔ pp.

Gives the items of cost of reproducing the Northern Pacific Ry. as estimated by Mr. W. L. Darling, Chief Engineer, and forming part of his testimony in the Spokane Rate Case before the Interstate Commerce Commission The unit prices on which the estimates for grading, track, tunneling, etc, are based are also given.

Metal and Reinforced Concrete Ties. R. R. Gaz., April 3, 1908; 1 p.

An editorial review of the use of metal ties and reinforced concrete ties on American railroads. The style of ties is briefly described and the success obtained by each style is commented upon.

Track Tanks. A letter by B. S. Murphy. R. R. Gaz. April 3, 1908; 1 p.

Giving some information as to the construction and operation of track tanks located on a curve.

The Handling of Locomotive Coal and Ashes. By C. F. Whitton. Proc. Can. Soc. C. E.; 14 pp.

Discusses and gives costs for comparison for handling coal and ashes for locomotives by locomotive crane, belt conveyor and bucket conveyor. Of interest to railroad engineers and officials.

Design and Performance of Locomotive Coaling and Ash Handling Plants. By W. G. Hudson. Eng. News, April 16, 1908, 3½ pp.

Describes several types of mechanical coaling and ash handling plants, gives suggestions on design and operation and presents several interesting tubular statements of operating costs. The article is a valuable one for railway engineers.

Compensation of Grades on Curves. Eng. News; April 16, 1908; 2 pp.

Summarizes the rules given by various authorities and the practice of a number of railways for figuring the compensation for grades on curves. A valuable summary for maintenance of way engineers.

Handling Rails With a Locomotive Derrick, Western Pacific Ry. Ry. & Eng. Rev., April 18, 1908; ⅔ p.

Describes and illustrates a device for handling seven rails at one time from stock piles to cars, and vice versa.

Rail Section and Specifications of the Pennsylvania System. Ry. Age, April 17, 1908; 2 pp.

Gives sectional drawing of 85 and 100 lbs. rails with specifications of these standards lately adopted by the Pennsylvania R. R. Process of manufacture, mechanical requirements and tests and inspection are all described.

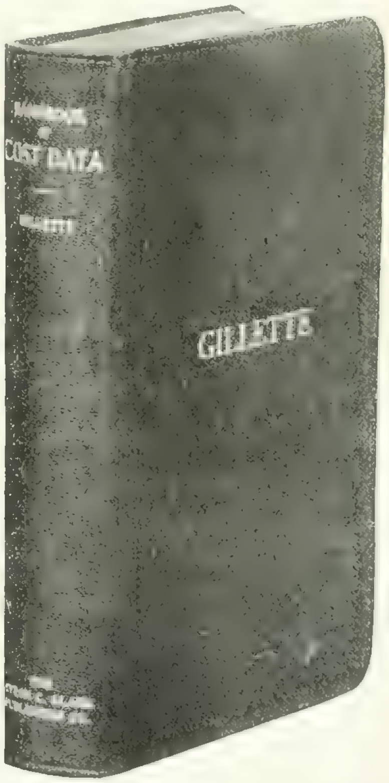
Report of Committee of the Railway Club of Pittsburg on the Revision of M. C. B. Rules of Interchange. Proc. Ry. Club of Pittsburg; 25 pp.

Gives in full the committee report that was adopted, showing the changes recom-

Handbook of Cost Data

By HALBERT P. GILLETTE,
M. Am. Soc. C. E. Editor "Engineering-Contracting"

"Cost Data" has broken all records for the sale of technical books. Over 10,000 copies were sold in less than two years; 1,600 in last three months. The book has over 600 pages of actual costs taken from the private records of engineers and contractors, and so itemized and analyzed as to be of inestimable value to any person who has to do with making bids and estimates or in checking estimates. This covers the whole field of contract work, giving the cost of labor and materials required for every kind of construction from the laying of sod to the building of reinforced concrete sewers. No detail of contract work has been too small to be described and recorded. Wages and prices of material are given in every case, so that proper substitution can be made where conditions differ. It gives also valuable data on methods of construction, thus enabling foreman to handle work in the most economical manner possible.



The general headings are:
- Cost-Keeping, Preparing Estimates, Organization of Forces, etc.
- Cost of Earth Excavation.
- Cost of Rock Excavation, Quarrying and Crushing.
- Cost of Roads, Pavements and Walks.
- Cost of Stone Masonry.
- Cost of Concrete Construction, all kinds.
- Cost of Water-Works.
- Cost of Sewers, Vitrified Conduits and Tile Drains.
- Cost of Piling, Trestling, Timberwork.
- Cost of Erecting Buildings.
- Cost of Steam and Electric Railways.
- Cost of Bridge Erection and Painting.
- Cost of Ry. and Topographic Surveys.
- Cost of Miscellaneous Structures.

24 Page Circular, showing Contents and Sample Pages, will be mailed FREE on request.

THE MYRON CLARK PUBLISHING CO.
355 Dearborn St. Chicago

cluded in the 125 rules of interchange, with comments on each change made.

New Rail Specifications, C. P. R. System. Can. Engr., May 1, 1908; 1½ pp.

Gives the specifications of the Canadian Pacific Ry. for 1908 for 85-lb. open hearth steel rails.

ELECTRIC RAILWAYS.

Proper Construction and Maintenance of Tracks in Electric Railway Service. By H. L. Weber. St. Ry. Jl., April 4, 1908; 3 pp.

An interesting discussion of the necessity of and methods for track maintenance work on both urban and interurban electric railways.

TUNNELS AND SUBWAYS.

Penstock With Reinforced Concrete Lining at the Northern Aluminum Work, Shawingan Falls. Eng. Rec., April 4, 1908; 3½ pp.

A description of the method of building this penstock. The tunnel was timbered differently from most tunnels, so that cars for construction were run at two elevations, one for the heading and one for bench. Most of the work was done during the winter in a severe climate.

BRIDGES AND BUILDINGS.

Methods and Cost of Constructing a Brick and Steel Wire Glass Plant at Greensburg, Pa. By A. E. Duckham. Eng.-Contr., April 15, 1908; 1⅓ pp.

General description of the method of constructing a 60x170-ft. brick building with itemized and unit costs.

Towers of the Manhattan Bridge Over the East River at New York City. Eng. News, April 16, 1908; 2 pp.

Describes the construction of these steel towers, giving main dimensions, weights, etc., and presents a summary of the loadings for which the towers were designed.

New Shops of Intercolonial Railway of Canada, Moncton, N. B. By C. F. Bristol. Proc. Can. Soc. C. E.; 13 pp.

A paper descriptive of these new shops, which were built of structural steel and reinforced concrete. Five buildings were erected. A description of the work done on each is given. Illustrated with drawings showing some details of construction.

Erection of French River Bridge—Canadian Pacific Ry. By C. N. Monsarrat. Proc. Can. Soc. C. E.; 8 pp.

A description of the method of building the piers and erecting this steel bridge, the main span of which was 415 ft. This span was of the through Warren truss type, and was erected on the river bank, and launched into position on the piers.

Report of Royal Commission on Quebec Bridge. Eng. Rec., April 18, 1908, 10 pp.

Being appendix 15 and 16 of the report, slightly condensed, giving a description of the experimental researches that have been made in connection with the building of the bridge and during the inquiry. Also gives a discussion of the theories of built up compression members.

Pontoon or Floating Draw Bridges. Eng. News, April 30, 1908; 5 pp.

Describes and illustrates a number of pontoon draw bridges built and in use in America and in India. A descriptive account of practice and experience with an unusual type of structure which is of considerable value as general information.

The Development of Building Foundations. By Frank W. Skinner. Eng. Rec., April 4; 10 pp.

Showing the development of deep foundations for tall office buildings that has taken place within the past 15 years. Illustrates and describes pile and grillage foundations, spread footings, anchorages, pneumatic caissons, and the improvements that have oc-

"I would have given $1,000.00 for this book a year ago."—W. H. Burk, Knoxville, Tenn.

"FIELD SYSTEM"

By FRANK B. GILBRETH, M. Am. Soc. M. E.

WHO THE AUTHOR IS.—Frank B. Gilbreth is the contractor who has made the "cost-plus-a-fixed-sum-contract" famous. In order to handle contract work scattered all over North America, Mr. Gilbreth found it necessary to develop a system whereby his foremen would execute work properly, promptly and economically. The code of rules and instructions to his foremen, and the printed forms for their reports, were bound in book form, and this book Mr. Gilbreth called his "Field System." Mr. Gilbreth's contracts have covered the widest possible range. Railways, canals, dams, factories, office buildings, whole industrial towns, are among the works that he has executed.

WHY ENGINEERS SHOULD STUDY "FIELD SYSTEM."—Every engineer should know how to manage men, for, whether he confines himself to purely professional work or enters into business of executing construction work, his ambition should be to direct the men under him in a manner that will secure the greatest possible efficiency. A revolution in the art of managing men is now in progress. Direct personal supervision was once deemed essential. To-day, however, "system" is fast supplanting personal supervision. By "system" we mean printed or written directions for employes to follow, and daily reports that show what the employes have done. System of this sort has recently been extended to the field survey work of the U. S. Geological Survey. While Gilbreth's "Field System" is not a system for the management of surveys, for example, it is rich in suggestions that can be applied in the management of any kind of field work, whether employes are engaged in surveying or in construction. Its rules and methods are applicable to office work, in so far as the principles involved are concerned. The book, in brief, is a treatise on the science of managing men by system. No engineer who aims to be more than a subordinate can afford not to have this treatise, written by a man who is an acknowledged adept in managing men.

Hundreds of engineers have gone into the contracting business during the past few years, and there is room for thousands more. But if they are to succeed in any great measure, it must be by the intelligent application of system and cost analysis. Gilbreth's "Field System" does not cover the whole field, nor was it written to cover it, but it does cover a very important part of the field, and a part upon which practically nothing has ever been written.

WHY CONTRACTORS SHOULD HAVE "FIELD SYSTEM."—Mr. Gilbreth has done in contracting what Mr. W. L. Douglas and Mr. Marshall Field have done in the mercantile field. He has taken a class of work involving endless detail, and has reduced the handling of these details to a system by virtue of which economy in construction and celerity in performance are secured, regardless of place or men. Every one has heard the expression, "one-shovel contractor," meaning a contractor capable of managing only one steam shovel at a time. The "one-shovel contractor" is the antithesis of the contractor having a system. The "one-shovel contractor" receives daily reports, it is true, but his reporters are his two eyes. The "one-shovel contractor" has a code of instructions for his men, it is true, but his ready tongue is the only leaf of a code bound between the cover of two jaws. The day of the "one-shovel contractor" is not yet gone entirely, but it will pass rapidly away. Every contractor should have a field system of his own, embodying his own experiences and covering his own necessities, but in the developing of such a field system no contractor can afford not to study the work of Mr. Gilbreth.

COPIES OF "FIELD SYSTEM" STOLEN.—When it became generally known that Mr. Gilbreth had supplied his foreman and superintendents with printed instructions, copies of the book were bribed from his employes, and photographed page by page, from cover to cover. Other copies were "lost," and thus made way with entirely. Huge salaries were used to hire away Mr. Gilbreth's superintendents, for the purpose of getting not only their trained services, but for their knowledge of the contents of the "Field System."

MAKING THE BOOK PUBLIC.—Mr. Gilbreth's action in making public his "Field System" in its entirety is without precedent in the world of business. It is an act that puts contracting on the high professional level of civil engineering. The civil engineer discloses his method of designing a structure, his purpose being to assist other engineers in doing as well. In the interest of scientific advancement the engineer places on record what he has found to be economic or effective. In the same spirit—we may call it the modern American spirit—Mr. Gilbreth has permitted publication of his private code of instructions to his men—his "Field System." He believes that contractors, and, indeed, all professional business men, will become far more efficient as managers of men if such systems as this are disclosed. He believes that in the general rise of efficiency that will occur all those engaged in business will share. He believes that those who are best fitted to be leaders will remain leaders. Character, experience and ability will have the same relative weight as ever. In these beliefs every broad-minded man ought to concur.

China is a nation that worships "trade secrets." It is a nation of industrial mutes. Their arts and their manufactures are taught by father to son, and zealously guarded. There has been no pyramiding of improvements upon one original invention as a base. The Chinese do not lack inventive ability. They are merely cursed by the curse of secretiveness. Their industries are plastered with signs of "No admittance," and are mummified in consequence. In striking contrast with the Chinese method is the American method. Our doctors, or engineers and our men of science generally have never concealed their discoveries or their improvements. Latterly our business men have shown a recognition of the truth of the general proposition that it pays the individual to share his discoveries with the rest of his fellows. Such generosity, in the final analysis, is simply an enlightened selfishness. The publishers of Gilbreth's "Field System" urgently request other contractors and business men to come forward with their systems, and put them permanently on record. Let business men generally adopt the altruistic policy that actuates professional men, and in its prosperity America will soon rise as far above its present level as it now stands above the level of the Chinese Empire.

PRICE OF THE "FIELD SYSTEM."—The book has 200 pages, bound in leather, and its price is $3 net, postpaid. Order now, before the edition is exhausted.

THE MYRON C. CLARK PUBLISHING CO.

355 Dearborn Street, Chicago

curred in the last named foundations. A general article on the subject.

Special Foundations for a New Edison Sub-Station. Eng. Rec., April 4, 1908; 1 p.

Describes a special pile made of a steel tube and filled with concrete used for this building, the ground on the site of which was very soft. It was necessary to put in a pile that would not jar the surrounding buildings by driving.

A Working Method for Masonry Arch Design. By Wm. T. Lyle. Eng. Rec., May 2, 1908; 1 p.

The method given of designing an arch is not meant for concrete but for stone masonry. In the discussion, the failure of arches by overturning, by sliding and by crushing is considered. Illustrated by drawings.

Displacement Diagrams of Framed Structures by Deflection Angles. By Myron S. Falk. Sch. Min. Quart. April, 1908; 10 pp.

A mathematical discussion of displacement diagrams, which offer a substitute for the Williott diagram. The diagrams considered give an exact solution where the Williott diagram is not exact.

Flooring vs. Stringers. By Louis Ross. Eng. News, April 23, 1908; 3 pp.

Presents a solution of the problem of finding the distribution of loads in floor and stringer or tie and stringer bridge floors. Working equations are given and their use illustrated by examples. An unusually interesting paper for bridge designers.

CONCRETE AND REINFORCED CONCRETE.

The Use of Reinforced Concrete in Engineering and Architectural Construction in America. By Ernest R. Matthews. The Surveyor, March 27, 1908; 6½ pp.

As its name implies this article deals with reinforced concrete construction in America. The article is general in character and is taken from a paper read before the Royal Society of Arts.

Reinforced Concrete Cantilever Girders in the Boyertown Building, Philadelphia, Pa. Eng. News, April 23, 1908; 1 p.

In steel building construction it is common practice to carry certain of the walls on beams cantilevered back to columns inside the building. A similar construction was worked out in reinforced concrete in the building named above and this article illustrates and briefly describes the reinforced concrete cantilever supports for certain of the walls.

Structural Materials Testing Laboratories at St. Louis, Mo. By Richard L. Humphrey and Preface by Joseph A. Holmes. U. S. Geo. Surv. Bull. No. 329; 84 pp.

This well illustrated phamphlet gives an account of the organization, equipment and operation of these testing laboratories, with the records kept of various tests of the materials used in concrete as well as structural concrete members.

The Edison Concrete House. By E. S. Larned. Cem. Age, March, 1908; 11 pp.

Record of the investigations made by the author into the method and cost of constructing concrete residences by molding in one piece in cast iron forms as proposed by Thomas A. Edison. The article is of interest particularly on account of the wide publicity given to this proposed method of construction.

Concrete Pile Foundations. By A. B. Clark. Proc. Engrs. Club, Philadelphia. January, 1908; 16 pp.

Describes the construction, method of sinking and various actual uses of piles consisting of heavy steel tubing in sections joined by interior splicing and after sinking filled with steel bars and neat Portland cement or rich mortar. An interesting general description of a method of pile construction which has been largely employed in New York building work.

New Reinforced Concrete Stadium for Syracuse University. By Ivar Kreuger. Cono. Eng., April, 1908; 12 pp.

A well written general description of the structural paterns and general methods of contruction of the large reinforced concrete structures built for Syracuse University. The method of design is discussed in some extent and there are interesting sections on form-work and on the method employed for finishing the concrete surfaces. There were used some 18,000 cu. yds. of concrete and some 500 tons of reinforcing steel.

Proposed 280-ft. Span Concrete Arch Bridge at Cleveland, O. Conc. Eng., April, 1908; 3 pp.

Describes and gives general plans for the 280-ft. span plain concrete arch bridge proposed for construction at Cleveland, O. The plans call for a bridge 708 ft. long, with a 40-ft. roadway and two 8-ft. sidewalks.

Comparative Advantages of Loose Bar and Unit Frame Systems of Reinforcement. By Emile G. Perrot. Eng. Contr., April 1, 1908, 1⅓ pp.

An interesting argument to show the advantages of unit frame reinforcement as compared with separate bar reinforcement. Among the claims urged for unit frames are, greater pier protection, greater accuracy of placing, more thorough tamping, less chance for error in erection, etc.

Reinforced Concrete in the Construction of Highway Bridges and Culverts. By James Mortland. Eng.-Contr., April 1, 1908, 2 pp.

Presents the merits of reinforced concrete in comparison with timber, steel, cast iron pipe and sewer pipe and gives a number of practical hints and directions for conducting concrete work in highway bridge and culvert construction.

Some Defects and Limitations of Reinforced Concrete Construction. Eng-Contr., April 8, 1908; 2⅔ pp.

Discussion by a number of engineers showing examples of defects in reinforced concrete work and outlining means for their promotion. The discussion gives some excellent hints and suggestions for doing reinforced concrete work.

Method of Constructing Reinforced Concrete Slope Paving for Holland Dikes. Eng.-Contr., April 8, 1908; 1⅓ pp.

Describes construction of reinforced concrete slope paving consisting of separate slabs connected and stiffened by beams which has been used with great success on recent shore protection work in Holland. The forms used and the method of construction employed are explained in details. A suggestive article for American engineers.

Method and Cost of Constructing a Concrete Reservoir, City Park, Pomona, Cal. By C. K. Fox. Eng.-Contr., April 15, 1908; 1 p.

The reservoir was oval, 77x40 ft., and 12 ft. deep and was constructed of reinforced concrete. Structural details are shown, methods of construction described and costs given in detail.

Comparative Costs of Mixing Concrete by Hand and by Machine. Eng.-Contr., April 15, 1908; ⅔ p.

Gives costs of hand and machine mixing for conduit work averaged from a large number of batches and from work done under different foremen. An unusually good set of records for comparison.

Reinforced Concrete Bridge Across the Rhine at Pyrimont, France. Eng. News, April 2, 1908; 3 pp.

General description of 3½-span arch bridge; clear spans 169 ft. long and 25 ft. rise supported on tall masonry piers. Arches consist of two ribs carrying columns braced across to form vents which support slab and girder roadway platform. General plans are given.

Skew Three-Hinged Reinforced Concrete

Cements, Mortars and Concretes

—Their Physical Properties

An up-to-date Compendium of Reliable Tests of Cements, Mortars and Concretes

By

MYRON S. FALK, Ph. D.

Instructor in Civil Engineering, Columbia University.

This book contains a very complete report of the results of tests made during the past fifteen years, and gives these results in tables and diagrams classified according to subjects. This is a reference book that should be in the library of every civil engineer. The contents include chapters on Chemical Properties of Cement, Physical Tests of Cement, General Physical Properties, Elastic Properties in General, Tensile Properties, Compressive Properties, Flexural Properties, Report on Uniform Tests of Cement by the Special Committee of the American Society of Civil Engineers, and Constitution of Cement.

Cloth, 6x9 inches; 184 pages; illustrated; price $2.50 net, postpaid.

Practical Cement Testing

By

W. PURVES TAYLOR, M. S. C. E.

Engineer in Charge of Philadelphia Municipal Testing Laboratories.

This is the first practical and exhaustive treatise on this important subject. It has already been adopted as a text-book by the University of Pennsylvania and other technical schools. Each chapter contains a minute description of the methods followed in the author's laboratory and many valuable suggestions as to the "how" and "why" of cement testing. The observations on the interpretation of results, one of the most difficult tasks of the novice, are especially pertinent and are expressed in a fair and conservative manner.

The book is so complete that it can be put in the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. The wealth of photographs and line cuts furnish the pictorial examples of how to conduct cement tests, and the 300 pages of texts are so explicit that even the most inexperienced man can soon learn the art of cement testing. Yet the book has not a superfluous paragraph. The list of chapters includes: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13) Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement than Portland, (16) Specifications (The Author's, Am. Soc. C. E.; Am. Soc. Test. Mtls.; Soc. Chem. Indust.; Corps Eng. U. S. A.; British Standard, Can. Soc. C. E.).

Cloth, 6x9 inches; 330 pages; 142 illustrations; 58 tables; $3.00 net, postpaid.

The Myron C. Clark Publishing Company

355 Dearborn St., Chicago

Arch at Denver, Colo. Eng News, April 2, 1908; 2 pp.

Describes the principal structural features of a skew arch consisting of eight parabolic, parallel, three-hinged arch ribs carrying columns supporting a slab and girder roadway platform. The spans of the ribs run from 132 ft. 5 ins. to 137 ft. 11 ins. The bridge cost by contract $3.98 per sq. ft. floor area.

Cutting a Hole Through a Concrete Dam With an Air Plug Drill and Chisels. By E. W. Schoder. Eng. News, April 9, 1908; ¼ p.

Describes briefly the methods of work and gives rate of progress in cutting a hole about 6 ft. in diameter 10 ft. through a concrete dam.

Design of Buttressed Dams of Reinforced Concrete. By R. C. Beardsley. Eng. News, April 23, 1908; 2⅔ pp.

Explains in some detail method of designing buttressed dams giving computations for dam 50 ft. high without apron. Some valuable information is also given regarding ice pressures and the methods of caring for them. A valuable article for designing engineers.

The Effect of Temperature Changes on Masonry. By Charles S. Gowen. Proc. Am. Soc. C. E. April 11, 1908; 11 pp.

An account of cracks that occur in the New Croton Dam, and observations made on the cracks for a period of two years, with a discussion as to how the changes in temperature effected the cracks. Illustrated with diagrams.

The Semi-Circular Masonry Arch. By A. E. Lindau. Proc. Am. Soc. C. E. April, 1908; 12 pp.

An analysis of the co-efficients for bending moments and thrusts on the ordinates to the equilibrium polygons of a semi-circular arch in the fixed ends. Various deductions are made from the analysis. A number of tables and diagrams are given.

Tests of Cast Iron and Reinforced Concrete Culvert Pipe. By A. N. Talbot. Eng.-Contr., April 22 & 29 and May 6, 1908; 9 pp.

Gives results of tests made on cast iron and reinforced culvert pipes 36 and 48 ins. in diameter, with an excellent discussion on the mechanics of pipes and rings subject to external pressure. The tests are unique and the test results and discussion are of high value.

Reinforced Concrete Caisson Breakwater, Algoma Harbor, Wis. Eng.-Contr., April 29, 1908; ⅔ p.

Describes construction of reinforced concrete caissons, 5x24x12⅓ ft., which are to be sunk on pile foundations, filled and capped to form new breakwater at Algoma Harbor on Lake Michigan.

Cost of Two-Story Reinforced Concrete Building. Eng.-Contr., April 29, 1908; ½ p.

The building for factory purposes had two stories and was 100x100 ft. in plan. The columns spaced 16x16 ft. carried slab and girder floor, girders and curtain walls. Complete costs of materials and labor are given.

Reinforced Concrete in the Construction of Highway Bridges and Culverts. By James A. Mortland. Mun. Eng. Mag., May, 1908; 4 pp.

A general article from a paper read before the Nebraska Cement Users' Association.

Reinforced Concrete Columns. By P. Gillespie and W. G. Swan. Can. Engr., May 1, 1908; 4½ pp.

The article contains a description of some recent tests made at the University of Toronto on concrete columns and discusses the subject of reinforced concrete columns in the light of these experiments.

SURVEYING AND DRAFTING.

Explorations for Hudson River Crossing of Catskill Aqueduct, New York City. By Alfred D. Flynn. Eng. News, April 2, 1908, 3⅓ pp.

Describes in considerable detail the ex-

Now Ready

CONCRETE CONSTRUCTION

METHODS AND COST

By

Halbert P. Gillette

M. Am. Soc. C. E., M. Inst M. E.,

Managing Editor, Engineering-Contracting

and

Charles S. Hill, C. E.,

Associate Editor, Engineering-Contracting.

THIS book handles the subject of concrete construction entirely from the view-point of the ***builder*** of concrete structures. The testing of cement, the physical properties of cements and concrete, and the design of concrete structures are not considered. The aim of the authors has been to eliminate all matter not germane to the constructing end of their subject. By doing this it has been possible to crowd a vast amount of detailed information on methods and cost of concrete construction into a volume of moderate size. The book is a treatise on the ***methods and cost*** of building in ***concrete.***

WHILE concrete design is not considered, no designer of concrete can be a really good designer without having a profound knowledge of costs and of practical methods of construction. This book will be of interest therefore to every engineer and architect who is engaged in designing concrete structures. It should be of particular assistance, however, to the contractor or engineer engaged in the actual work of making and placing concrete.

THE methods given are practical methods and they are so given that the practical man can use them. The costs given are actual costs, itemized, analyzed and reduced to units. Costs of material, costs of transporting, costs of mixing, costs of placing, costs of tamping, costs of finishing, costs of forms, costs of bending and placing reinforcement, costs of waterproofing, costs of superintendence, costs of plant, interest charges, depreciation charges are all given, and to make these costs useful, the conditions and the methods of doing the work are stated in each case.

Cloth, 6 x 9 inches, 700 pages, 306 illustrations, $5 net, postpaid.

The Myron C. Clark Publishing Co.

355 Dearborn St., Chicago, Ill.

plorations made to determine the character of the rock-cross-sections for the several possible crossings of the Hudson River by the 500,000,000-gal. Catskill aqueduct for the New York City water supply. Extracts from reports on the geological nature of the crossings are given, and the extent and character of the borings made are described for the adopted Storm King crossing. Besides wash and core drill borings from the surface, two shore shafts were sunk and horizontal core borings were made across river between shafts.

EARTH AND ROCK EXCAVATION.

Railroad Grading by Hydraulic Methods on the Chicago, Milwaukee & St. Paul Ry. Eng. Rec., May 2, 1908; 4 pp.

Tells of the outfit and methods being used to sluice earth from some large cuts and place it in two very high embankments in building a new line of railroad in the state of Washington.

Method of Building the Tunnel of the Detroit Water Works. By James Ritchie. Engr.-Contr., April 1, 1908; 1 p.

Describes the methods used in building a tunnel under the Detroit River, also the make up of the working gangs, likewise the power plant.

A Protest Against Government Ownership of Dredges. By William P. Ryan. Engr.-Contr., April 1, 1908; 1¼ pp.

An argument presented before the Rivers and Harbors Committee against government ownership and operation of dredges, showing that it is a socialistic and uneconomical condition of affairs. A plea is made for this work to be done by contractors.

The Shrinkage of Earth in a Colorado Reservoir Dam. Engr.-Contr., April 1, 1908; ¼ p.

R. M. Hosea states that the shrinkage of earth in the Sugar Loaf reservoir, during construction, was 5.44 per cent.

Diagram for Determining Percentages of Different Sizes of Stone Delivered by Rock Crushers. Engr-Contr., April 1, 1908; ½ p.

This diagram gives the percentages of different sizes of crushed stone from a crusher. The diagram is said to be accurate for this purpose. Some hints are also given on crushing stone.

Method of Building a Small Cofferdam. By W. H. Boughton. Engr.-Contr., April 8, 1908; ¾ p.

Describes the method of building a cofferdam for a bridge pier, showing that various defects occurred that could have been prevented by using a little forethought.

Methods of Grubbing Stumps and Trees With Machines. Engr.-Contr., April 8, 1908; 1⅔ pp.

Describes the method of grubbing stumps and trees by several special machines, by logging apparatus, by hoisting engines, locomotive cranes and pile drivers.

A Problem in Excavation, What Tools to Use. Engr.-Contr., April 8, 1908; ⅔ p.

A letter and an answer giving a problem of building a reservoir embankment from two different borrow pits, and showing in each case how the work can be done, and the kind of outfit to use.

Core Test Drilling on New Lock Site—"Soo." By Wilber M. Rich. The Michigan Technic, February, 1908; 4 pp.

Describes the method of making test borings through soft materials and rock with a Davis Calyx drill. The work was done in connection with the design of a lock at Sault Ste. Marie, Mich.

Cost of Earth Work on Belle Fourche Dam, South Dakota. Eng. News, April 2, 1908; ⅔ p.

Gives itemized cost of earth dam construction using steam shovels with dump cars and elevating graders with wagons. General methods of work are described. In the steam shovel work 305,000 cu. yds. were placed with an average output per shovel per 10-hour day of 951 cu. yds. at an average cost of 49.7 cts. per cu. yd. In the grader work 199,000 cu. yds. were placed with an average output per grader per 10-hour day of 556 cu. yds. at an average cost of 26.5 cts. per cu. yd.

The Method of Sinking a Shaft in the Joplin District with Power Drills. Engr.-Contr., April 22, 1908; 1½ pp.

Describes the method of sinking, showing the arrangement of holes, and work each set of holes do in blasting. Similar information is given in regards to sloping. Other details are also described.

Subsurface Investigations on the Catskill Aqueduct, Board of Water Supply. Eng. Rec., April 18 & 25, 1908; 6 pp.

A paper by Robert Ridgway before the Municipal Engineers of New York. Tells of the amount of exploration work that has been done, and describes in detail the methods and results of the boring of test holes. Includes test boring both on land and in the Hudson River.

Cost of Diamond Drilling in Mexico. By J. F. Bennett. Engr.-Contr., April 29, 1908; 1 p.

An account of diamond drilling and details of the cost done in silver mines in Mexico. The costs are all given in lin. ft. and in U. S. currency.

The Cost of Spreading Earth in Rolled Embankment. Engr.-Contr., April 29, 1908; 1 p.

A letter from W. W. Patch showing a high cost of spreading earth. Editorial comment is made showing the cost given is excessive owing to wrong methods being used in doing the work.

MISCELLANEOUS.

Quantities; Should They Form Part of the Contract. By F. C. Hunt. The Surveyor. April 3, 1908; 1 p.

Abstract of a paper read before the Surveyors' Institution. The writer gives reasons why the quantities should not form part of the contract.

The Cost Specialist. By Frederic H. Leland, Jr. Worcester Poly. Inst., March, 1908; 6 pp.

Tells of the duties of a cost specialist, how he studies the business in hand, devises a cost keeping system, then, from the results shown by this system, the manufacturing and selling organization is improved and at times entirely re-organized.

Notes on the Application of a Depreciation Charge in Railway Accounting. By F. A. Delano. Ry. Age, March 27, 1908; 2½ pp.

Comments are made on the ruling of the interstate commerce commission to introduce this item into railway accounting, then is considered depreciation of equipment, track, bridges, buildings, shops and shop tools and of the plant as a whole. The general features are also discussed, as limit of depreciation and flexibility of the charge.

A Method of Moving Large Trees. Eng Rec., April 11, 1908; ¼ p.

A method of moving large trees by a small force of men is illustrated and described. The earth is kept on and around the roots by means of wooden staves and iron hoops, and the whole mass, frequently weighing as much as 70 tons, is moved from the old site to the new. The work was done at Pittsburg, Pa.

Steam Consumption in Air Compressors. Engr.-Contr., April 8, 1908; ⅔ p.

Two tables are given and their use commented upon, showing the steam consumption of air compressors, under single stage and two stage compression, and with varying air pressure.

Formulas for the Design of Cableways. By E. B. Durham. Eng. News, April 16, 1908; 2⅓ pp.

The author states briefly the considerations governing cableway design and thus

Rock Excavation

Methods and Cost

By

HALBERT P. GILLETTE,

M. Am. Soc. C. E. Editor "Engineering-Contracting."

One superintendent who purchased this book about a year ago writes us that he has cut the cost of his drilling and blasting practically in two since he received the book and applied the methods given by Mr. Gillette. We doubt whether such a statement has ever before been truthfully made of any books except those written by Mr. Gillette. His books are practical books for practical men, and the keynote throughout is economy—how to save money on the work and how to increase the output.

"Rock Excavation" has chapters describing:

Rocks and Their Properties.
Methods and Cost of Hand Drilling.
Machine Drills and Their Use.
Steam and Compressed Air Plants.
The Cost of Machine Drilling.
Cost of Diamond Drilling.
Explosives.
Charging and Firing.
Methods of Blasting.
Cost of Loading and Transporting Rock.
Quarrying Stone.
Open Cut Excavation.
Methods and Costs on the Chicago Drainage Canal.
Cost of Trenches and Subways.
Subaqueous Excavation.
Cost of Railway Tunnels.
Cost of Drifting, Shaft Sinking and Stoping.

Cloth, 5½x7 in., 384 pages, 56 figures and illustrations; $3 net postpaid.

Earthwork

And Its Cost

By

HALBERT P. GILLETTE,

M. Am. Soc. C. E. Editor "Engineering-Contracting."

A book that should be in the hands of every man who is in charge of "moving dirt," whether with pick and shovel, plow and scraper, steam shovel and dredge, or any other tool for digging and conveying earth. The contents include:

The Art of Cost Estimating.
Earth Shrinkage.
Earth Classification.
Cost of Loosening and Shoveling.
Cost of Dumping, Spreading, Rolling.
Cost of Wheelbarrows and Carts.
Cost by Wagons.
Cost by Buck and Drag Scrapers.
Cost by Wheel Scrapers.
Cost by the Elevating Grader.
Cost by Steam Shovels.
Cost by Cars.
How to Handle a Steam Shovel Plant.
Summary and Table of Costs.
Cost of Trenching and Pipe Laying.
The Cost of Hydraulic Excavation.
Cost of Dredging.
Miscellaneous Cost Data.
Earth and Earth Structures.
Rapid Field and Office Survey Work.
Overhaul Calculation.
A Small "Home-Made" Dipper Dredge or Steam Shovel.
Detailed Description and Drawings.
Cost of Making the Dredge.
Cost of Operating.

Cloth, 5x7½ in., 260 pages, 50 figures and illustrations; $2.00 net postpaid.

The Myron C. Clark Publishing Co.
335 Dearborn St., CHICAGO

presents and explains the formulas used and the calculations necessary for computing the design. The article is an excellent one.

Cost of Building Electrical Conduits in Baltimore, Md. Eng.-Contr., April 1, 1908; [illegible] pp.

Describes methods adopted and gives costs of conduit and vault work done from 1898 to 1905, inclusive. The organization of the work is shown and the tables cover prices of materials, wages, and unit costs of all parts. One of the most valuable articles on conduit work ever published.

Cost of Treating Piles With Teredo Proof Paint. Engr.-Contr., April 1, 1908; 1-6 p.

Gives cost of preparing piles for paint and of applying three coats of paint to piles in government work in the Gulf of Mexico.

A Revolving Pile Driver. Eng. News, April [illegible], 1908, ½ p.

Shows dimensioned general drawings of and describes construction of revolving pile driver. Drawings are useful.

A Graphical Comparison of Various Log Rules. By A. H. Morse. Eng. News, April 9, 1908; 1 p.

The chart shows curves for seven common log rules, illustrating great amount of discrepancy.

Bulletin of the Bureau of Labor No. 74 Depart. Commerce and Labor. [illegible] pages.

Discusses the legal liability of employers for injuries to their employes. A summary of foreign workman's compensation acts is given and also reports of the various state bureaus of labor, and foreign statistical publications. In the end numerous decisions of courts affecting labor are recorded.

The Cost of Power in Small Units. By Wm. E. Snow. Eng. Mag., May, 1907, 7 pp.

Consists mostly of tables giving costs per horse power for the installation of small steam plants, and also the cost per horse power for operation of the plant for a year. Simple and compound condensing and non-condensing plants are considered. Such data as are given are difficult to obtain.

Characteristics of Wire Rope Tramways with Some Figures on Cost of Operation. By W. S. Gemmert. Eng.-Cont. April [illegible], 1908, 1 1-3 p.

Classifies tramway systems and discusses characteristics and advantages of each class. Figures are given of operating force required and capacities and costs of operation are stated in general terms.

The Use and Abuse of Cost Data. By W. W. Patch. Eng News., April 30, 1908. 1 p.

The author names various omissions which render cost data of little value in making estimates, argues the necessity of knowing all governing conditions and concludes that the "chief advantage accrues on the work or with the parties where they originate and is found in the certainty with which they disclose weak points in organization or extravagant methods of working."

Rochester's Public Market. Mun. Jl. and Engr., April 1, 1908. 4½ pp.

An illustrated descriptive article on the public market of Rochester, N. Y. The public markets of a number of other cities are also briefly described.

Municipal Account Keeping. Mun. Jl. & Engr., April 1, 1908; 2½ pp.

An abstract of a paper by Harrison P. Eddy, read before the Massachusetts Highway Association. The article shows the value of cost keeping to municipal departments.

Winnipeg's Experiment with Sewer Ventilation Plants. Can. Engr., May 1, 1908; 1½ pp.

Contains reports of the City Engineer and City Bacteriologist on experiments with sewer ventilation lamps. Data as to cost of lamps and maintenance are given

The world's authority on this great subject.
The most expensive book ever issued and sold for $5.00.

Concrete and Reinforced Concrete Construction

By HOMER A. REID, Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; $5 net, postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete, on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter — material never previously published. This work is complete, up-to-date and original. No other book on concrete contains one-tenth so much of the very latest data on tests, theory and practice.

In a two-column review of this book, "Manufacturers" Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

Write for 16-page Table of Contents.

THE MYRON C. CLARK PUBLISHING CO.

355 Dearborn St. **CHICAGO**

BOOK REVIEWS.

Concrete Construction—Methods and Cost. By Halbert P. Gillette and Charles S. Hill. Myron C. Clark Publishing Co., Chicago, Ill. Cloth, 6x9 in., pp. 690; 314 illustrations; $5, net, postpaid.

This volume considers concrete construction from a viewpoint differing materially from that of any of the other standard books on concrete. It is a treatise on the methods and cost of doing concrete work, for the use of the construction engineer and contractor. The design of concrete structures and the properties of concrete as a structural material are not considered, but a very large amount of information is given regarding the methods used and the machinery and tools employed in concrete construction, and particular attention is devoted to the cost of concrete construction. Cost data have been collected and compiled for all classes of concrete construction, from simple pavement foundations to complex reinforced concrete buildings, sewers, tanks, etc. In respect to the amount of cost data of this character the book excels anything that has heretofore appeared in print and it is safe to say that few even of the large contractors for concrete construction will have as great an amount and as wide a range of data. Taken by themselves alone and as mere records of fact, without the least regard to the work of the authors in their analysis and discussion, these data must be of great value to constructors of concrete work.

The first five chapters of the book and the three concluding chapters may be said to apply to concrete construction in general, as they discuss operations and present data applying equally to all kinds of structures, such as selecting and preparing materials, proportioning, hand mixing, machine mixing, constructing ornaments and waterproofing. Chapter VII on Methods and Cost of Laying Concrete in Freezing Weather; Chapter VIII on Methods and Cost of Finishing Concrete Surfaces and Chapter IX on Methods and Cost of Form Construction, also fall into the same classification. Each of the remaining chapters discusses specifically some particular kind of operation, such as subaqueous concreting and rubble and asphaltic concrete or some particular type of structure, such as bridges, buildings, retaining walls, conduits, reservoirs, sidewalks, pavement foundation, pile foundations, bridge piers, locks, dams, breakwaters and piers.

The plan of treatment in each chapter has been first to state the general character of the problem and to describe the general methods applicable to its solution and to follow these data with detailed analyzed data for specific pieces of work. Thus in the chapter on "Methods and Cost of Reinforced Concrete Building Construction," an extended discussion of (1) construction, erection and removal of forms, (2) fabrication and placing of reinforcement, and (3) mixing, transporting and placing concrete is followed by detailed costs of six difficult reinforced concrete buildings, with descriptions of the methods and machinery employed. Methods of construction are given as well as costs of doing work. Tools, machinery, plant layouts, etc., are all given attention. As a volume specifically for the construction engineer and contractor, the book should find a wide field of usefulness. The publishers' work is generally good, both in respect to the illustrations, which are numerous, and in respect to typography and printing. There is an adequate index.

Concrete. By Edward Godfrey. Published by the author, Pittsburg, Pa. Leather, 4x6½ in.; pp. 448; illustrated; $2.50 net.

This volume is "Book Two" of the author's Structural Engineering. It contains a large amount of very good material, whose utility to the working engineer is greatly reduced by its poor arrangement, by repetition, and by the distracting effect of the author's controversies with other engineers over disputed points of theory and design. To the trained designer in concrete the author's polemics will do little damage and will even afford spirited reading, but to the student they will prove confusing, if not worse. They should have no place in a book of the character that this book is supposed to be. We repeat that the book has much that is of value to any engineer who will take the trouble to sort the wheat from the chaff.

The Conard System of Structurally Reinforced Concrete. By W. W. Conard, C. E., Norristown, Pa. Paper, 6x9 in.; pp. 31; illustrated.

While written to advertise a patented system of reinforced concrete building construction, this pamphlet is of technical value to the engineer. Typical designs for building, work of concrete reinforced by structural shapes are shown and methods of calculation are explained and illustrated by examples. The tables give the resisting moments of channels and angles, when used as reinforcement for concrete beams; also the resisting moments of 1 lin. in. in width for concrete beams of rectangular and tee sections and values of shear bars.

Proceedings of the Forty-First Annual Convention of the American Institute of Architects, 1907. Glenn Brown, Secretary, Washington, D. C. Paper, 7x10 in.; pp. 176; illustrated.

This volume contains the full proceedings of the annual convention held at Chicago, Nov. 18-20, 1907. Among the papers of general interest is one on the "Corrosion of Steel," and two on "The Artistic Expression of Concrete." These three papers can be read with advantage by engineers.

Comparative Tests of Carbon, Metallized Carbon and Tantalum Filament Lamps. By T. H. Amrine, University of Illinois Engineering Experiment Station, Urbana, Ill. Paper, 6x9 in.; pp. 44; illustrated.

The three types of lamps named were tested to determine their comparative efficiency, cost of operation, maintenance of candle-power and efficiency, life, quality of light, distribution of light, susceptibility to voltage variations and ability to withstand rough usage. The conclusions are summarized as follows:

"From the study of these lamps it appears that the carbon filament and the tantalum filament lamps can cover adequately all the phases of incandescent lighting that are now covered by the three types. For low power costs and for rough or unusual uses and for small candle power units the carbon lamp is best and often the only one that can be used. For higher costs of power upon poorly regulated circuits and for lightening the load upon overloaded stations the tantalum lamp is best. It is not recommended by its manufacturers for use upon alternating current, yet the results obtained show that although it does not do so well upon alternating current as it does upon direct current circuits, it still gives better economy for the higher power costs than the carbon lamp. The principal fault of the metallized lamp is that of mechanical weakness, which probably does not exist in the larger sizes where a heavier filament is used, so that for units of 40 or 60 candle power or above, this type of lamps is very satisfactory."

Portland Cement Mortars and Their Constituent Materials. Results of Tests made at the Structural Materials Testing Laboratories, Forest Park, St. Louis, Mo. By Richard L. Humphrey and William Jordan, U. S. Geological Survey, Washington, D. C. Paper, 6x9 in.; pp. 130; illustrated.

This is the third of the series of bulletins to be issued by the concrete materials laboratories, and the first to contain records of actual test results. The records given cover some 25,000 tests. The report may be divided into two parts; the first dealing with tensile, compression and other tests including chemical analysis of Portland cement of different brands and of the mortars mixed therewith in which standard sand was used; the second part dealing with tests of mortars prepared by mixing typical Portland cement with 22 sands, 12 gravel screenings and 25 stone screenings procured from different parts of the United States and mixed in different proportions. The test results are given in tabular and diagram forms with only such explanatory text as is necessary to make the conditions understood. Scarcely any attempt is made to draw conclusions from the results.

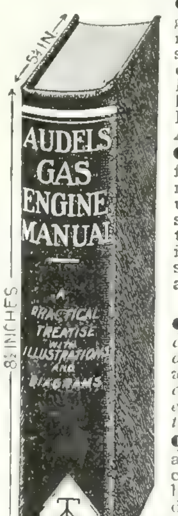
The Strength of Chain Links. By C. A. Goodenough and L. E. Moore, Engineering Experiment Station, University of Illinois, Urbana, Ill. Paper, 6x9 in.; pp. 73; illustrated.

This bulletin records a series of experiments on chain links and circular rings, covering a period of two years, made for the purpose of confirming or disproving a theoretical analysis of the stresses in links and rings. A comparison of calculated and measured distortions affords the desired test. The result of the experiments is a complete confirmation of the analysis. Having a reliable theory, the bending moments and maximum stresses are calculated for links of various forms and the results of such calculations are applied to the formulas for the loading of chains given by Unwin, Bach and Weisbach. It is shown that the usual formulas for chain loads give maximum tensile stresses of 33,000 to 40,000 lbs. per sq. in., and maximum compressive stresses of 60,000 lbs. per sq. in. New formulas for safe loads are proposed. The bulletin is concluded with four appendices giving in full the theoretical discussion which is the basis of the experimental work. This bulletin will be of special interest to all engineers and manufacturers who are concerned in any way with hoisting and transmission. Copies may be obtained upon application to the Director, Engineering Experiment Station, Urbana, Ill.

Catalogs Worth Having

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and

GAS ENGINE MANUAL



¶ This volume just published gives the latest and most helpful information respecting the construction, care and management of **Gas, Gasoline** and **Oil Engines, Marine Motors** and **Automobile Engines,** including chapters on Producer Gas Plants and the Alcohol Motor.

¶ The book is a practical educator from cover to cover and is worth many times the price to any one using a gas engine of any type or size. Contains 512 pages, 27 chapters, 156 diagrams, size 5¼ x 8¼ inches, weighs 2 pounds, handsomely bound, and is in every way a fine volume.

SPECIAL OFFER

¶ *The only way the practical merit of the* MANUAL *can be given is by an examination of the book itself, which we will submit to the readers of Engineering-Contracting, free for examination, to be paid for or returned, after looking it over.*

¶ Upon receipt of the following agreement (which can be either cut out or copied), the book will be immediately forwarded.

No money in advance required, sign and return

Theo. Audel & Co., 63 Fifth Ave., New York

Kindly mail me copy of "Audels Gas Engine Manual," and, if found satisfactory, I will immediately remit you $2.00, or return the book to you.

Name..........

Address..........

....

E. C.

state that you saw the catalog mentioned in *Engineering-Contracting.* If you are in the market for tools, machinery or supplies tell us and we will notify promptly the leading manufacturers

No. 0702. **Buckeye Electric Blue Printing Machines.**—The Frederick Post Co., Chicago, Ill.

This machine consists of a stationary vertical glass cylinder on the outside of which are spread the original and the paper while a lamp moves vertically up and down inside the cylinder. The construction and operation of the machines are described and directions given for using it. The following statement is made in the pamphlet:

"The first blue prints shown in the United States were exhibited by Switzerland at the Philadelphia Exposition in 1876. The same year the Buckeye Engine Company adopted this method of copy, but as blue print paper could not be secured in America, it was necessary to prepare it by hand in accordance with a formula secured direct from France. As our blue prints circulated and reached the hands of hundreds of people who had never before seen anything of the sort, we were flooded with requests for information which would enable others to begin their use. This was always cheerfully given and thus we were in a small way partly responsible for the present universal use of blue prints."

No. 0703. **Raymond Concrete Piling.**—Raymond Concrete Pile Co., Chicago, Ill.

This 76-page pamphlet is devoted largely to illustrations of Raymond concrete pile foundation work and of buildings which have such foundations. The text describes the characteristics of Raymond piles and the method of constructing them, with remarks on carrying capacity, cost, etc.

No. 0704. **Wire Rope Tramway Engineering.**—The Trenton Wire Co., Trenton, N. J.

This 15-page pamphlet is a reprint of a paper having the above title contributed to "Cassiers Magazine" by Mr. S. S. Webber, Chief Engineer, Trenton Iron Co. The paper is wholly descriptive in character.

No. 0705. **Medusa Waterproof Compound.**—Sandusky Portland Cement Co., Sandusky, Ohio.

This 20-page circular describes the method of using this compound which is mixed dry with the cement and gives results of tests and statements from users and from the technical press regarding its waterproofing qualities. Full directions for using the compound are given.

No. 0706. **Reinforced Concrete Posts.**—D. & A. Post Mold Co., Three Rivers, Mich.

This 4-page circular describes an outfit for molding reinforced concrete posts. Directions are given for operating and caring for the outfit and for attaching the fence.

No. 0707. **Steel Sheet Piling.**—Carnegie Steel Co., Pittsburg, Pa.

This 16-page pamphlet gives a very good description of the characeristics of the two styles (Friestedt and United States) of steel sheet piling made by the firm named. Driving, pulling, watertightness, and advantages as compared with wood are discussed. The sketches and tables are useful.

No. 0708. **Steam Shovels.**—The Vulcan Iron Works Co., Toledo, O.

This 120-page general catalog of steam shovels describes and illustrates both the standard and special shovels made by the firm named. The general construction is outlined and each style of shovel is illustrated and described by abbreviated specifications. A special section is devoted to electric shovels and there is a full description of the company's new revolving shovel and of its 3,000-gal. steel water tank car.

No. 0709. **Cantractors' Supplies.**—Contractors' General Supply Co.. Chicago, Ill.

This firm handles a large line of tools and equipment for building, paving, excavating, sewer building, concrete working, punches, mines and manufacturing plants which is catalogued and described in this 82-page pamphlet.

No. 0710. **Concrete Fence Post Mold.**—H. S. Credlebaugh, New Carlisle, O.

The post made by the mold described in this 16-page pamphlet is molded with holes through which wire nails. The pamphlet also describes a hand-power concrete mixer and a tamper with one round corner.

No. 0711. **Lackawanna Railroad Terminal at Hoboken.**—Mississippi Wire Glass Co., New York; N. Y.

This pamphlet gives a very good general description of the main structural features of the large new terminal station of the Lackawanna railway at Hoboken, N. J. Line drawings and several fine halftones illustrate the buildings, train shed, ferry slips and other structures. The trainshed which is of unique construction is glazed with wire glass which is also used for the buildings generally. The pamphlet is well worth securing.

No. 0712. **A Triple Alliance in Optics.**—Bausch & Lomb Optical Co., Rochester, N. Y.

This interesting pamphlet has been prepared to record the association under the above name of the well known optical firms of Bausch & Lomb Optical Co., Carl Zeiss Optical Works of Jena, and George N. Saegmuller. A historical sketch is given of each of the companies named which contains some interesting biographical information and a large amount of useful history of the development of lense making.

No. 0713. **Water Towers.**—Des Moines Bridge & Iron Works, Des Moines, Ia.

This pamphlet illustrates and describes briefly a large variety of water towers and stand pipes built by the firm named. There are also tables of fire streams, pump capacity, friction in pipes and general information for waterworks engines.

No. 0714. **Cement Making Machinery**—Power & Mining Machinery Co., Cudahy, Wis.

This 86-page pamphlet describes in detail a full line of machinery for cement mills. Rock crushers, ball and tube mills, screens, rotary kilns, conveyors, scales, etc., are all given attention and there is a good brief explanation of cement manufacture.

No. 0715. **Galvanized Steel Culverts.**—Kelly Foundry & Machine Co., Waterloo, Ia.

This 16-page pamphlet gives some very good general information regarding culvert construction comparing various materials and type of culverts. The special merits of galvanized steel pipe culverts are set forth, its manufacture, carrying capacity, strength and non-corrosive qualities being discussed at some length.

No. 0716. **Steel Tapes.**—Chicago Steel Tape Co., Chicago, Ill.

This little pamphlet describes the merits of the steel tape made by the firm named and gives details of the Eureka tape repairer. This repairer consists of a thin sheet of metal folded in the form of a sleeve and coated on the inside with a combination of solder and flux which solders the sleeve in place over the broken ends.

No. 0717. **Steel Filing Cabinets.**—Art Metal Construction Co., Jamestown, N. Y.

This 56-page pamphlet illustrates and describes steel cabinets for all kinds of filing purposes. Library stacks, desks, tables and book cases all of steel are also shown.

No. 0718. **Distilled Water.**—Wagner Water Still Co., Chicago, Ill.

This pamphlet contains a very readable article on the uses and advantages of distilled water for various purposes and also illustrates and describes briefly the automatic still operated by gas or steam which is made by the above named firm.

No. 0719. **Grinding, Pulverizing and Separating Machinery.**—Raymond Bros. Impact Pulverizer Co., Chicago, Ill.

This handsomely printed pamphlet describes the Raymond roller mill in the various forms for grinding all classes of materials. The mill is described in detail and illustrated by half-tones and line drawings. Similar details are given of the company's system of air separation. Dust collectors are also described and tables of dimensions and prices of all machines are given.

No. 0720. **Well Screens.**—E. E. Johnson, St. Paul, Minn.

The Johnson screen has the inlet slot extending spirally around the tube; in shape the slot is narrowest at the outside and by widening inward prevents choking. This pamphlet describes the screen and gives tables of dimensions, etc.

No. 0721. **Contractors' Tents.**—American Tent & Awning Co., St. Paul, Minn.

This catalog lists a large line of tents, awnings, camp furniture and canvass goods of all kinds. Complete tables of sizes and prices are given.

Personals.

Mr. W. D. Larrabee, of Los Angeles, Cal., has been appointed Chief Engineer of the proposed Redlands & Yucaipa R. R.

The Morava Construction Co., of Chicago, Ill., has been granted a permit to do business in Texas. Its Texas headquarters will be in Dallas.

Couchet & Thurston, Designing and Constructing Engineers, have removed to their new offices in the Wells Fargo building, San Francisco, Cal.

Messrs. John L. Newman, Benjamin Newman, Jr., and Carl Vineyard have organized the Newman Sewer Construction Co., of Evansville, Ind.

Mr. Fred Schneider has been reappointed City Engineer of West Allis, Wis. Mr. Schneider was formerly a member of the Board of Public Works of Milwaukee, Wis.

Mr. Henry B. Drowne, Assoc. M. Am. Soc. C. E., at present an Assistant Engineer with the State Board of Public Roads of Rhode Island, has been appointed Instructor in Civil Engineering at Brown University, Providence, R. I.

Capt. Louis F. Garrard, Jr., Constructing Quartermaster, U. S. A., has been relieved from further station at Mobile, and will take station at Fort Morgan, Ala., in connection with his duties as Constructing Quartermaster of that post.

Mr. Charles Richardson and Marion Mullen have entered into a partnership under the firm name of the Richardson Cement Paving Co. and will engage in paving work. The offices of the company are at 405 Howard Ave., Biloxi, Mass.

Mr. H. G. Perring, Secretary of the Engineers' Club of Philadelphia, and formerly engineer with the Keystone Fireproofing Co., has been secured by the General Fireproofing Co. of Youngstown, Ohio, as District Manager at Philadelphia with offices in the Drexel building.

Mr. C. S. Davis, formerly Chief Engineer of the Massillon Bridge Co., and after the reorganization of the company Chief Engineer of the Toledo-Massillon Bridge Co., in charge of the contracting, has opened an office as Consulting Engineer in the Ohio building, Toledo, O.

The Goldschmidt Thermit Co. of New York City has established an office and works at 103 Richmond St., W. Toronto, Ont. The new branch is under the management of Mr. E. C. Rutherford, of Toronto, for several years the manager of the Magann Air Brake Co., and of the Canadian Brake & Supply Co.

Mr. Howard Egleston has resigned his position as Engineer of Bridges and Buildings on the Southern Pacific Railway in Mexico and has opened an office in the new James building, Chattanooga, Tenn., where he proposes devoting himself to construction engineering, contracting on the "cost-plus-a-fixed-sum" plan.

Mr. Ernest McCullough has been appointed Consulting and Sales Engineer of the Northwestern Expanded Metal Co. of Chicago, Ill., succeeding Mr. A. W. Rush, resigned. Mr. E. H. Jones has also resigned as Secretary and General Manager of the above company and is succeeded by Mr. Howard N. Foote as General Manager and Mr. W. G. Bartlett as Secretary.

Mr. Howard Soule has been engaged by the Intercepting Sewer Board of Syracuse, N. Y., to investigate and report to the board the effect of the proposed new Phoenix dam upon the proposed intercepting sewer. In connection with the barge canal, the Phoenix dam is to be raised about 4 ft., thus increasing the level of Onondaga lake, into which the intercepting sewer is to empty.

Robert W. Hunt & Co. have established an analytical chemical laboratory in connection with their St. Louis office, 1445 Syndicate Trust building. The laboratory will be under the direction of Mr. J. B. Emerson, who for several years past had charge of the metallurgical part of the wheel foundry of the Mt. Vernon Car Co. Previous to that engagement he was in the employ of the Illinois Steel Co.

Messrs. C. E. Holme, I. H. Whitenack and H. L. Muchemore have purchased the business heretofore conducted under the name of M. T. Holme and have incorporated under the laws of the state of New York as The Holme Company, to do engineering-contracting work, especially shoring, wood and steel sheet-piling, bridging, underpinning, house-moving, test-boring, pile driving and concrete foundation work. The offices of the company will be at 14-16 Pulaski street, Brooklyn, N. Y.

CONTRACTORS AND ENGINEERS
SAVE LABOR
USE
Nash's Expeditious Measurer
A book of 200 pages of indexed tables, showing at a glance the cubic contents of any stone or package according to its length, breadth and depth. Used by Contractors, Quarrymen and Engineers everywhere. Order of your bookseller or the publisher. $2.00 Postpaid.
A. L. NASH
17 State Street NEW YORK
Send for Sample Pages
SAVE TIME
AVOID ERRORS

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER,
CHAS. S. HILL,
C. T. MURRAY,
F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . PRESIDENT
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance) —
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3.00** a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Copy for regular advertising must be received not later than Friday preceding date of issue in which it is to appear. "Proposals," "Wants" and "For Sale" announcements can be inserted as late as Tuesday morning.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

How to Key Advertisements and the Desirability of Keying.............291
Some Ideas on Steel Forms..........291

CONCRETE SECTION:

Gravel Washing and Screening Plant for Concrete Dam and Power House Work..........292
Method of Constructing Reinforced Concrete Underpinning for 14-Story Building on Line of Washington St. Tunnel, Boston, Mass..............293

EARTH AND ROCK SECTION:

Method and Cost of Blasting 3,500 Stumps..........294
A Ditching Machine that Cuts a Ditch with Sloping Sides................295
Experiments to Determine Physical Characteristics of Materials at Gatun Dam Site, Isthmian Canal..........295

GENERAL ARTICLES:

The Development of Agricultural Drainage in Illinois and Iowa—Controlling Laws, Physical Conditions and Costs........................296
Ten Additional Letters Commending the American Society of Engineering Contractors........................301
METHODS AND COSTS..................300
LETTERS TO THE EDITORS................301
CATALOGS WORTH HAVING..............302
PERSONALS........................302

How to Key Advertisements and the Desirability of Keying.

In our last issue we discussed the subject of catalog writing, and told why the most effective sort of advertising is the kind that leads a reader to send for a catalog. We purpose briefly discussing the keying of advertisements.

An advertisement is said to be keyed when a different name or address or a different catalog number is used in each of the different journals, the object being to ascertain how many inquiries can be traced to each journal. There are several different methods of keying advertisements, among which are the following:

1. Keying by different street numbers.
2. Keying by different department numbers.
3. Keying by different postoffice box numbers.
4. Keying by using different names as, "sales managers," or the like.
5. Keying by interjecting different superfluous initial letters or making other changes in the firm name.
6. Keying by asking the reader to send for catalogs designated by letters or numbers which differ in the different periodicals.

The foregoing are the most commonly used "keys." The first and the last are the most popular. Readers are apt to omit street numbers entirely, especially where the advertiser is located in a small town; but, since the main object of keying is to ascertain the *relative* merits of the different journals as advertising media, an occasional omission of a street number is not serious. The catalog key is obviously a key, but is not objectionable on that account, for the average reader is quite willing to assist the advertiser and the journal in this manner, realizing that it is a courtesy which both will appreciate.

The other methods of keying are self-explanatory, except possibly the fifth method. If the firm name is John L. Smith, the ad may be keyed by inserting a superfluous initial thus: John L. T. Smith. If the firm name is The Jones-Smith Co., it may be keyed thus: The T. Jones-Smith Co. Other modifications of this idea will suggest themselves.

The use of coupons is scarcely a method of keying, although it performs the same purpose and often with better effect. There is a certain psychological effect about a coupon, but the chief reason for the success lies in the little trouble that is involved in filling in a blank ordering a catalog. The great success of the advertising done by the International Correspondence School may be attributed largely to the uses of coupons in every advertisement.

Some advertisers raise objections to keying their advertisements, one of the most common objections being that successful keying is impracticable where the addresses of branch offices are given in the advertisement. There are two ways of answering this objection effectively. In starting any intelligent campaign of advertising it is usually wise to omit the addresses of branch offices entirely. What is lost in time required to reach the branch office with an inquiry is more than gained by the definite knowledge secured as to the relative merits of the different journals, and therefore as to the amount of the advertising appropriation which should be expended in each. If, however, it is imperative that the addresses of branch offices be given, then the advertisement may read thus: "Send all inquiries for catalogs to the main office only, and ask for catalog E."

It is astonishing what the keying of advertisements will often disclose. The average advertiser is influenced strongly by the plethoric appearance of the advertising pages of a paper, without considering the number or quality of its readers. Keying his advertisements will disclose that some papers are overrated if judged by appearances, whereas others are many times more effective than would have been suspected by looking at the advertising pages.

Selecting advertising media is a good deal like digging molluscs. You can't tell by the looks of the shell what meat is inside. Pry the shell open and the contents may be mere sand. Keying an advertisement is the prying open of the shell. In our next issue we shall discuss the importance of the caption of an advertisement and how to prepare attractive captions—one of the most important elements in the art of writing successful advertisements.

Some Ideas on Steel Forms.

The great advantage of wood for form work in concrete construction is that it is readily fabricated in the field. It is also readily available. Steel is markedly inferior in both these respects; otherwise it is generally equal or superior to wood for the purpose named. The quality in which steel is most superior to wood is durability. To develop steel successfully in competition with wood for form work its superior durability must be utilized to the fullest measure; this statement is incontestable.

A number of engineers have been and are now working on the problem of steel forms. Examples of their labors are given by the steel wall forms recently put on the market. These wall forms are comparatively simple applications of steel to form work; the success of the application lies in the fact that unit construction is practicable and the same units can be employed over and over. In a word, the durability of the steel is utilized. A more familiar example of steel form work is the steel center now so commonly used for concrete sewer and aqueduct construction. Here again the properties of unit construction and of repeated use of the units are exemplified. A still better illustration of the point being made is furnished by the concrete block machine and the various steel molds for ornamental shapes, pipes, posts, etc.; here the form becomes a mold for repeated use.

In general, it may be asserted that wherever steel has come to be commonly used for forms it has been for work where unit construction and repeated reuse of the units are possible. It is probably safe to go even further and assert that under no other circumstances will steel obtain a suc-

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

steel plate compared with wood as a material for form work. To our mind the inventor has his problem stated in these two assertions. It is to apply unit form construction to all classes of concrete work. To what extent is it likely that this can be done?

As noted above, several steel forms for wall work have been worked out. Steel forms for conduits, as has also been stated, are commonly and successfully in use. One of the most successful uses of steel forms of which we have knowledge is a steel rib and channel lagging center for several very extensive jobs of tunnel work in Chicago. Steel vault forms for telephone conduit work have also been most successfully used in the same city. For plain walls, conduits, for tunnel lining, culverts and small arches generally, and for manholes and vault work in which standard sizes are possible, steel forms have, it seems to us, an immediate field of economic use. The same statement is, we believe, true of tank and bin work. In building work we have a more complex problem.

As buildings in reinforced concrete are now designed, about the only places that steel forms appear possible are wall construction, column construction, and centers for floor slabs. One prominent engineering firm in the northwest has used slab center sheets of corrugated iron in place of planks. Continued use of steel in place of wood in these places by this firm would seem to argue the reasonable success, if not the advantage, of metal. If steel forms are to become generally used in building work it would seem essential to adopt in designing standard construction units, that is, standard column spacing, wall and floor panel widths, etc. The possibilities in this direction are considerable and we believe that they will be utilized as time goes on, and that when this is done the steel form will present a strong claim for a place in building work.

In conclusion, we believe that contractors could economically make far greater use of steel in form work than they do. Taking conduit construction (sewers and aqueducts) as an example, there are many advantages in steel forms. Some builders, at least, of conduit forms rent them, supplying the forms built to profile and dimension and taking them back when the work is done. There is in many cases a saving in capital invested by this plan. Generally, too, steel conduit forms are more easily taken down, moved ahead and set up than are wooden forms. They usually give a better surface and they keep their shape better with continued use. These statements are equally true of steel vault forms, steel centers for tunnel lining, etc., and we could cite many specific examples in proof, but that is not our purpose. We wish to urge merely that contractors can with advantage devote some time to investigating the possibilities of steel forms for many classes of concrete work.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Gravel Washing and Screening Plant for Concrete Dam and Power House Work.

The dam is being built across the Yadkin River near Rockingham, N. C., by the Rockingham Power Co., and is 1,468 ft. long between abutments, with wing walls and a core wall running into the banks. It is approximately 50 ft. high, 10 ft. wide at the top and 60 ft. wide at the bottom, with a vertical upstream face and a long ogee curve for its downstream face. It is being built of 1-3-5½ concrete with 30 per cent rubble. The dam, power house and collateral works call for about 117,000 cu. yds. of concrete.

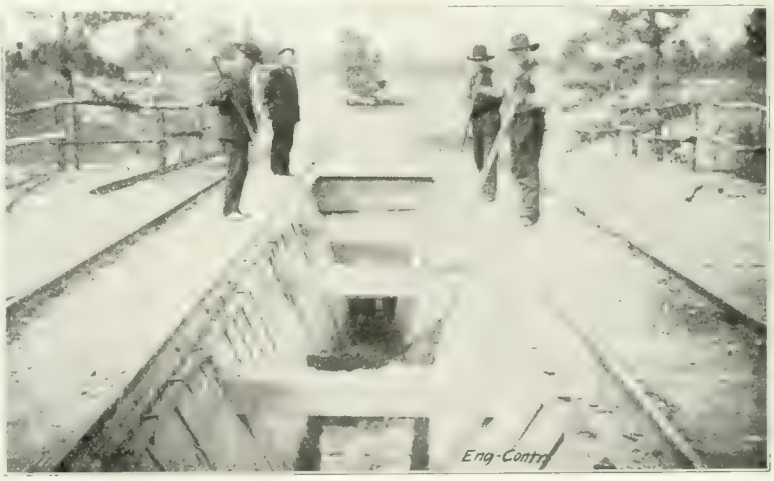


Fig. 1—View of Sluice Boxes Where Material is Dumped.

To supply the sand and gravel for this concrete a gravel pit covering some 40 acres and from 2 to 12 ft. in thickness has been opened up at a point about 6 miles from the dam site and about 1 mile from the main line of the Seaboard Air Line Ry. A spur track runs from the railway to the working plant and from the working plant a narrow gage road runs to the gravel pit. The gravel is excavated by wheel scrapers and loaded by means of a bridge and trap into 4 cu. yd. dump cars. These cars are hauled two in a train by a "dinkey" to the charging hoppers of the working plant. These hoppers are carried on trestles and form the upper end of a sluice leading to the screens and loading plant some 250 ft. away. Figure 1 is a view of the charging hoppers. As will be seen, the dump cars coming from the pit run in tracks on each side and are side dumped directly into the hoppers. Four cars are used so that two are being loaded at the pit while two are en route or being dumped.

The sluice is a wooden trough about 3 ft. wide and 1 ft. deep carried on a light pole trestle. To one side of the charging hoppers stands an elevated tank which is kept filled by a 5-in. steam pump taking water from a small stream about 600 ft. away. When a train load (two cars) of pit gravel has been dumped into the hoppers, water enough is drawn from the tank to float the gravel down the chute. The lower end of this flume as shown by Fig. 2 terminates in an inclined screen with ½-in. mesh. The water and sand pass through the screen into hoppers below, while the pebbles roll along the screen and pass over its end into the gondola car shown. The water overflows the sides of the sand hopper carrying off the loam and lighter materials while the sand settles and, when the hopper is filled, is drawn off into the cars beneath. The arrangement is shown clearly by Fig. 2.

The pit gravel is of good quality with not more than 5 per cent. of stone over 1½ ins. in size. The sand content is slightly in excess of the amount needed for the 1-3-5½ mixture used. The cost of the washed gravel and sand in the cars is about 60 cts. per cu. yd.

For the information from which this description has been prepared, we are indebted to Mr. W. A. Leland, Chief Engineer, Federal Construction Co., Rockingham.

The expenditure of over $100,000,000 in railroad construction work is contemplated by a bill before the Italian Parliament.

Method of Constructing Reinforced Concrete Underpinning for 14-story Building on Line of Washington Street Tunnel, Boston, Mass.

The section of the Washington St. tunnel passing the Ames Building, Boston, Mass., involved in its construction the underpinning of this building, which has a height of 200 ft. above the earth on which its foundations rest. The plan adopted for placing this underpinning is described in the report of the chief engineer of the Boston Transit Commission, Mr. Howard A. Carson, as follows:

The Ames Building is not a steel building, although its floors are made of steel and masonry. The street walls are of stone with brick backing and are so thick as to bring a weight on the underlying earth as great, probably, as would be given by a modern steel building (other conditions remaining the same) having a height of over 280 ft. The alignment of the Washington St. tunnel and the need of a passenger station in this vicinity required that the westerly wall of the tunnel at the Ames Building should substantially coincide with the westerly building line of the street. The bottom of the tunnel masonry was to be 28 ft. below the foundations of the building and 48 ft. below the sidewalk level. The foundations of this building, however, project into the street practically the whole width of the sidewalk. Consequently, unless the encroaching foundations should be removed, the tunnel would have to be built under them and a considerable portion of the weight of the building would rest on the top of the tunnel. The conditions are indicated by Fig. 1. The cross-section shown on this is taken not far from the middle of the building. South of this the foundation footings project over the tunnel to a greater and to the north of this section to a less distance over the tunnel than is shown on this sketch. The Transit Commission asked the trustees of the building to remove the encroaching foundations. After some discussion it was decided to allow them to remain.

Fig. 2—Showing Sand and Gravel Cars in Position Being Loaded.

A question which early presented itself was whether the whole area of the foundation supporting the Washington-St. wall should receive a new masonry support, *i. e.*, underpinning, to be carried down to the bottom of the subway excavation, or whether only so much excavation should be made as was necessary for the displacement of subway. An objection to the latter plan was that even with great care and skill some of the earth to the west of the subway and underlying and supporting the remaining portion of the street wall of the building might be disturbed. If the former plan was adopted, however, the earth lying still farther west and underlying the foundation masonry of the first row of piers might be disturbed. Mr. Isaac Blair and Mr. Wm. H. Cavanagh, who have had extensive experience in underpinning and supporting buildings in Boston, were consulted, as well as other engineers. Some preferred one plan and some the other. Mr. John E. Cheney, however, a civil engineer of long experience and high standing, who until the time of his death in September, 1906, was engineering adviser of the trustees of the Ames Estate in this matter, strongly favored the latter general plan and asked that so much of the building as was formerly supported within the street lines be supported on top of the tunnel. Mr. Cheney did not work out any details for carrying out this idea, but he approved of those which were finally worked out and which were partially carried into effect prior to his death. Mr. Frederick H. Fay, who had assisted Mr. Cheney in studying the weight of the building and its distribution, advised the trustees after Mr. Cheney's death.

After discussion, the Transit Commission determined to adopt the general scheme favored by the engineering representative of the trustees of the Ames Estate, and the details of this were accordingly worked out and carried into execution.

In furtherance of this plan it was at first proposed to make the westerly wall of the tunnel of a row of metal or other pipes to be forced down by jacks reacting upward against the foundations of the building, these pipes being about three feet in diameter and touching each other. For various reasons, however, this idea was abandoned and details were worked out which did not embody any novel feature of this plan. The westerly wall was formed of a series of hollow piers, each one being begun at the top, *i. e.*, immediately under the foundation, and extended downward, step by step, to the bottom of the tunnel wall. The piers were made hollow in their earlier stages, so that excavation could be carried on inside of them and for the further reason that it was necessary to unite, as a monolith, the reinforced masonry of the arch and invert with the masonry which would finally fill the hollow piers and constitute a large part of the westerly wall of the tunnel. The details are given in the following paragraphs.

A trench was first excavated along the front of the building to the bottom of the foundation. A drift about 4 ft. wide and 4 ft. high was then driven under the foundation, at right angles to the trench, to the back of the proposed tunnel wall. A row of jacks was placed on each side of this drift to make up as far as possible for the supporting power of the excavated earth. At the farther end of this drift, on the line of the tunnel wall, a vertical rectangular shaft, 3 ft. x 3 ft. 9 ins. in cross-section, was driven down to about 3 ft. below the grade of the bottom of the tunnel invert. As the shaft was driven its walls were made of concrete slabs reinforced with embedded steel angles and rods, forming a hollow pier. The slabs were fastened together vertically and horizontally by splicing angles bolted in the inside corners of the shaft. Steel foot plates were driven out from the interior of the bottom of the pier so as to project 9 ins. beyond the outer edges of the shaft lining at right angles to the tunnel wall, temporarily increasing the footing area until additional supporting area was supplied by the construction of the tunnel invert. After plugging the bottom of the pier with about 3 ft. of concrete, the proper portion of the load of the building was transferred to the pier by driving steel wedges between the bottom of the building foundation and steel I-beams bedded on top of the pier walls or lining. The wedges were so placed that the load was carried through the transverse walls and the back wall of each pier, leaving the wall on the tunnel side unloaded, as the method used involved taking out some of the face slabs, as stated later on.

As soon as the first hollow pier was completed and the proper load transferred to its footing, a parallel drift was dug and a second pier, touching the first, was built in the same manner. This process was continued, forming a cellular wall 3 ft. thick. All void spaces around and between the piers were filled with grout.

Thirty-four of these hollow piers were put down, twenty-five of which were directly under the building foundations. For about one-third of the piers, where the ground was soft, rectangular steel shields about 3 ft. deep were used. These were jacked down as the excavation proceeded, the concrete slabs being bolted in place behind them in a manner similar to that employed in ordinary shield tunnelling. The shields were left in place at the bottom of the pier. If they should turn into rust they will still be more solid than the earth which they replace. After the entire combined underpinning and tunnel wall was in place the westerly barrel of the tunnel was built in sections 7 to 8 ft long. Some of the concrete slabs were removed from the face of the underpinning wall where it was joined by the tunnel arch and invert, thus allowing the steel reinforcing rods from the arch and invert to be carried through the openings into the hollow piers. These piers were filled with concrete when placing the concrete for the invert and arch, thus making the pier filling monolithic with the rest of the tunnel section, as shown by Fig. 1.

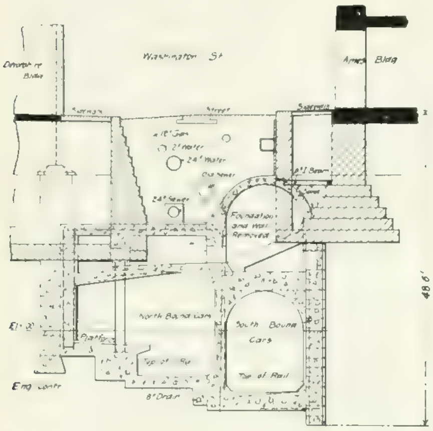


Fig. 1.

This method, with some modifications to suit the different conditions, was later used to underpin the Washington-St. front of the Devonshire Building on the opposite side of the street.

Owing to the unusual problems involved and the consequent desirability of being able to alter the plans or vary methods at any stage of the work, the section was built almost entirely by day labor under the direct control of the engineering department. Several contractors, including Coleman Brothers and John E. Palmer, furnished men and tools for the work. A total of 9,215 cu. yds. of excavation and 3,250 cu. yds. of concrete was involved. Of the former, about 800 cu. yds. was done under contract by Patrick McGovern.

The work of underpinning the Ames Building and the construction of the westerly barrel of the tunnel was carried on with three 8-hour shifts per day. The remainder of the section was then completed with two 10-hour shifts per day. The men were paid by the hour and wished to work at least 10 hours per day.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Method and Cost of Blasting More Than 3,500 Stumps.

The Long Island R. R. bought a tract of land, in 1905, in Suffolk county on Long Island, in order to carry on experimental agricultural work. The tract was situated in the waste lands of the island and the first work to be done was to clear it of timber. A force of men was put to work cutting down the trees and undergrowth, and this work was followed by the stump blasting.

The blasting crew consisted of two men only, except for the three last days of the work, when a third man was employed to hasten the finishing of the job. The work was done during the latter part of the summer and the fall of the year, good weather prevailing most of the time.

One man employed was accustomed to handling explosives and had had experience in blasting stumps. He was paid $3.50 for a 10-hour day. The second man was a common laborer and was paid $1.50 per day. The third man, used for three days, also had handled explosives. He was paid $3 per day.

In all 10 acres of land were cleared. The blasting gang made the hole under the stump and charged it, setting off the charge, but the work of cleaning up after the blast was done by other men. The stumps were mainly white oak and chestnut, varying in size from 18 ins. to 7½ ft. in diameter. Many of the stumps ran from 4 to 4½ ft. in diameter. Each acre of ground was measured off and a careful record kept of the number of stumps blown on each acre.

The following table shows the number of stumps blasted and the amount of dynamite used:

Acre No.	Number Stumps.	Lbs. Dynamite Used Per Acre.	Lbs. Dynamite Per Stump.
1	293	145½	0.50
2	310	152	0.49
3	301	169½	0.56
4	270	150¼	0.56
5	280	211¼	0.75
6	305	191½	0.62
7	285	178	0.62
8	337	188½	0.56
9	334	198½	0.59
10	797	446	0.56
Total	3512	2031	0.58

The soil was a light loam with sand or gravel underlying it. Naturally the amounts of dynamite used per stump varied with the size of the stump. Small stumps up to 4 ft. in diameter needed ½ lb. of dynamite. Stumps from 4 to 6 ft. in diameter needed from 1 to 3 lbs., while the largest stumps, measuring from 6 to 8 ft. in diameter needed from 3 to 4 lbs. of dynamite. The largest stump blown was a chestnut 7½ in diameter which took 3½ lbs. of dynamite. It will be noticed that the average per stump was not quite 0.6 lb. All the dynamite used was 40%.

In blasting the stumps the helper made a hole with an auger or bar under the stump, so the charge would be close up to the stump and near the center. The dynamiter prepared a large number of cartridges with fuse and caps in them in advance, so that when a number of holes had been made, all he had to do was to place the charge and tamp up the hole. Double tape fuse was used to put off the blast. The fuse was cut to lengths to explode the load within a given number of seconds, just enough time being allowed for a man to run to a safe distance. For most of the stumps, fuse a foot and a half in length was used, and when the end was split to allow of easy lighting, it took 30 seconds for this fuse to burn to the charge, hence this was known as a "30 second length." Care was taken to use enough dynamite to blow out the entire stump, but not to waste the explosives. Small stumps were blown out whole, but the larger ones were split up by the blast so they could be easily handled.

The number of stumps blasted per day varied somewhat, according to the size of the stumps and the difficulties encountered. The best day's work for two men was 110 stumps, while on other days they did 97, 60, and 99, the average being 84 for two men, for the job. On one day that three men worked 160 stumps were blasted. In clearing an adjoining piece of land 1 man by himself blasted in one day 100 stumps, but he had prepared the charges the day previous. The cost of blasting the stumps for the 10 acres was:

Labor.

1 man, 40 days, at $3.50	$140.00
1 man, 40 days, at $1.50	60.00
1 man, 3 days, at $3.00	9.00
2031 lbs. 40% dynamite at 15 cts.	304.65
3600 caps at 75 cts. per 100	27.00
7000 ft. D. T. Fuse at 45 cts per 100.	31.50
Total	$572.15

This gives a cost per stump of the following:

Labor	$0.059
Dynamite	0.086
Caps	0.008
Fuse	0.009
Total	$0.162

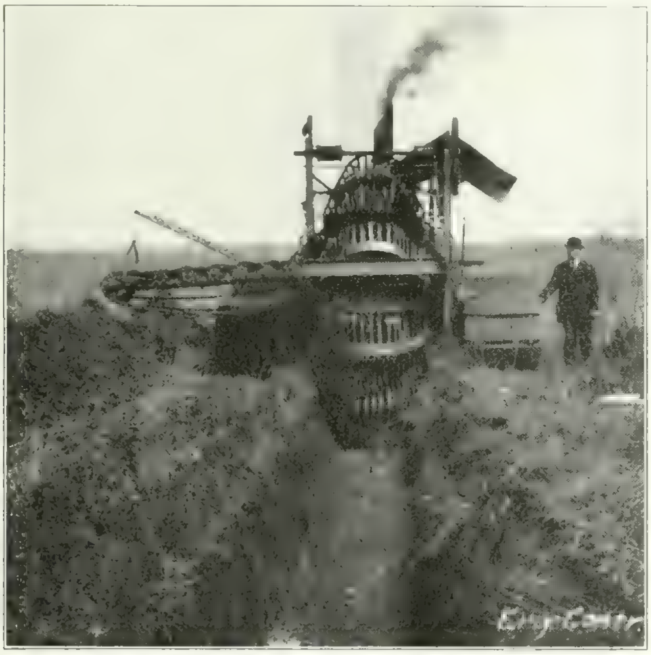
The cost per acre was $57.22.

This work was done under the direction

of Mr. H. B. Fullerton, special agent of the Long Island R. R. Co., to whom we are indebted for the information. For other articles on methods and cost of clearing and grubbing land see ENGINEERING-CONTRACTING Feb. 27, 1907, Oct. 17, 1907, Dec. 25, 1907, March 25, 1908, and April 8, 1908.

A Ditching Machine That Cuts a Ditch with Sloping Sides.

The machine shown in the accompanying cut is one that was designed for prairie soil. It is provided with "apron traction wheels," 3 ft. wide by 11 ft. long, which present such a wide surface of contact that the machine can work in swamp land where ordinary wheels would sink out of sight. These "apron wheels" really form a self-moving, continuous railway track and wheels combined in one device. The "apron" consists of planks fastened to endless chains. The planks underneath the wheels remain stationary on the ground even when the machine is moving forward. The endless chains serve to pick up the planks in the rear of the wheel and deposit them in front. The steel frame of the machine is carried on 5-in. iron wheels, spaced 1 ft. apart. Not only do these "apron wheels" serve excellently in marshy ground but also on soft, dry sand where an ordinary traction engine would become stalled.



Traction Ditcher, With "Apron Wheels."

It will be noted that the machine cuts a ditch with sloping sides. Skeleton buckets were used on this particular machine for digging water soaked soil, but it is believed that where sand is encountered it can be handled reasonably well by the use of solid buckets.

This ditcher is manufactured in several sizes, cutting ditches from 2 ft. to 12 ft. wide on top, and with any side slopes desired. The slopes are made by the center cutters, which are located in front of the carrying buckets, and these can be cut to any slope or shape desired when the machine is being assembled. Changes of buckets and cutters will be provided for any owner who wishes to dig ditches of different shapes.

Only two men are required to operate the machine, beside one man with horse and wagon to haul fuel and water. For the 12-ton machine shown in the photograph only 800 lbs. of coal are needed per 10-hour day.

With this plant and crew a ditch 3½ ft. deep, 2 ft. bottom, and 4½ ft. top was excavated at the rate of 5 lin. ft. per minute, working in wet and very soft ground at Raceland, Louisiana.

The ditcher is self propelling and can be used for draining swampy lands, for cleaning out old ditches, and for digging the side ditches for roads.

The machine is made by the Buckeye Traction Ditcher Co., Findlay, Ohio.

Experiments to Determine Physical Characteristics of Materials to be Used in the Gatun Dam of the Isthmian Canal.

Experiments on an extensive scale are now being made at the Gatun Dam site on the Isthmian Canal for the purpose of investigating the various soils and rocks which will be used in the construction of the dams and also the materials that are found in the foundations and in the portions of the ground underlying the embankments and walls to be constructed. It is expected that these experiments will show clearly the physical characteristics of the materials themselves, and demonstrate their condition when placed in embankments or when forming foundations subjected to excessive loads or heavy water pressure.

A station has been established at Gatun for these experiments, which will be made under the direction of Mr. C. M. Saville, assistant division engineer, Gatun Dam Division. In the April 8 issue of the Canal Record Mr. Saville describes the experimental work as follows:

The principal investigations are:

1. Experiments with soils in a wooden tank to ascertain the slope of the water in the embankment; the amount passing through the soil; the best method of depositing soil in order to make it resist the passage of water; and the effect of a load on the embankments.

2. Experiments to determine the frictional resistance of soils and rocks to the passage of water.

3. Experiments to determine the frictional resistance of soils to pressure.

4. Wash drill and diamond drill borings.

5. Test pits in the dam location on Gatun island, the lower part of the Chagres valley, and on the hill at the spillway.

6. Experiments to determine the action of the materials under heads of water similar to that expected in the dam.

7. Determination of the best mixture of available materials for making impervious embankments and the action of these mixtures under pressure and when exposed to the action of water.

Beside the borings and soundings that are being made to investigate the material in the foundations of the dam, other investigations are under way for the purpose of developing the location and extent of the best materials from which to construct the big embankment. Thus far the returns are of a most satisfactory character, both as to quality and quantity.

(1) Experiments are being made in a water-tight wooden tank, 80 ft. long, 6 ft. wide and 8 ft. high. In this a section of a dam is being constructed one-twelfth the size of the actual structure. Into the tank materials are being pumped under conditions similar to those that will exist in the dam itself. When completed, the experimental section will be subjected for a considerable period to water pressure and careful records kept of the rate at which water may percolate into the material. These observations will be made by means of glass gauges set up outside the tank at distances of 5 ft. apart, and connected with perforated horizontal pipes with the interior of the embankment. In this way the slope of saturation through the embankment can be determined and the actual dam itself so designed that no water of percolation can find its way to the outer slope until it has lost all its pressure and power of damage. Several dams of various materials will probably be constructed in this tank from time to

time, in order to determine the best materials for use in the actual work.

(2) Experiments are being made in galvanized iron tanks about 3 ft. in diameter and 5 ft. high. In these a layer of the material to be investigated is placed and exposed to a constant head of water. Careful observations by glass gauges make it possible to determine the quantity of water that will pass through under various heads of water, and the thickness of material that will be necessary to make the embankment practically impervious.

Studies of the land slides at various points on the isthmus are being made and experiments made with large size sliding boxes to determine the friction angle and the coefficient of friction for the various materials.

The wash drill and diamond drill investigations are on a much more extensive scale than previously undertaken, and the ground is being so thoroughly explored, and to such great depth, that it is felt that no conditions can obtain that will materially change the plans after they have once been decided upon.

On Gatun island, at a point about half way between the old channel of the Chagres river and the French canal, an exploration pit is being excavated, which it is proposed to carry down a distance of at least 100 ft. This pit is 20 ft. square, and has now reached a depth of 18 ft. As yet the materials excavated have been compact clay and sand, containing very little water, a hand pump, intermittently worked, being sufficient to drain the pit. The excavation is being carefully watched, and it is planned every 10 ft. and oftener if the material changes, to make mechanical analyses and filtration determinations.

In order to determine the action of the soil and rocks when exposed to heavy water pressure, cylinders of the materials to be investigated are enveloped in strong iron tubes, varying in size from three inches to eight inches in diameter, and then the specimen is subjected to water pressure varying from 20 lbs. to 80 lbs. per square inch, corresponding respectively to 46 ft. and 185 ft. head. Abrasion tests are being made of the several rocks found, and also experiments to determine the resisting qualities of the rocks when exposed to the eroding action of a stream of water under pressure.

Beside the ordinary information obtainable from wash and diamond drill exploration regarding the character of the underlying strata, investigations are also being made to determine the velocity of flow of the underground water. These determinations are being made by the electrical method devised and successfully used by Professor Schlicter on the U. S. Geological Survey work. The underground water conditions are also being investigated by seepage and pumping tests.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Development of Agricultural Drainage in Illinois and Iowa—Controlling Laws, Physical Conditions and Costs.*

BY JACOB A. HARMAN †

The laws of Illinois and Iowa are based upon the so called common laws of England. The riparian rights under the common law consist in the right of the owner of any land adjacent to a navigable stream to the free use and flow of all of the waters of such stream in a state of nature, such parties being permitted to make any reasonable use of the waters of the stream, provided they are returned to the stream without impairment or change, for the similar use of the owner immediately below. This principle has been extended under the common law practice to apply to all drainage through the natural water courses whether in large streams, small streams or across the flat prairies where there are no defined channels, so that under the common law it is impossible for any drainage to be accomplished by any individual or group of individuals except by the concurrence of all who might be interested or whose rights might become affected by the result of the construction of drainage ditches. It was not a question whether drainage would be a benefit or damage to the lands of the adjacent owner, but it was merely a question of the absolute right which had been decided by the court in the negative.

Illinois Drainage Laws. In 1870 a new constitution was adopted by the people of the state of Illinois in which a provision was contained that "the general assembly may pass laws permitting the owners or occupants of land to construct drains or ditches for agricultural and sanitary purposes across the lands of others." In 1877 the general assembly passed a joint resolution for an amendment to the constitution providing for the passing of laws for "the organization of drainage districts and vest the corporate authorities thereof with power to construct and maintain levees, drains and ditches, and to keep in repair all drains, ditches and levees heretofore constructed under the laws of this state, by special assessment upon the property benefited thereby." This amendment to the constitution was adopted by the people in November, 1878, and was proclaimed during the same month. In 1879 the general assembly passed "an act to provide for the construction, reparation and protection of drains, ditches and levees across the lands of others for agricultural, sanitary and mining purposes and to provide for the organization of drainage districts." Efforts to organize drainage districts during the early years of this act met with the most determined opposition, which resulted in a general revision of the act in 1885 to overcome the objections which had been sustained by the courts. During the same year, 1885, the legislature passed an entirely separate and distinct act for the organization of drainage districts "for agricultural and sanitary purposes." These two drainage acts provide separate and complete methods of organizing drainage districts and the provisions of one do not in any way apply to the provisions of the other. Both of these acts have been found constitutional and have been availed of very extensively in the organization of drainage districts. The act of 1879 is popularly known as "The Drainage and Levee Act" and the act of 1885 is popularly known as "The Farm Drainage Act." Under both of these acts drainage districts are organized upon a petition of a majority of the adult owners of not less than one-third of the lands within the proposed drainage district or under the Farm Drainage Act a petition signed by the owners of the major part of the land in said proposed district.

In the Drainage and Levee Act the petition is addressed to the County Court of the county in which the major portion or all of the land is located and when filed with the clerk of said court notice is given to the owners of land within the proposed district and upon a hearing, if the court is of the opinion that the proposed drainage will be of benefit to the lands, said court will appoint preliminary commissioners to investigate and report with plans and specifications for the proposed work. If the commissioners report and recommend plans for drainage, a further hearing is had and notice given to all land owners, and if upon such hearing the court is convinced that the plans are feasible and that the cost will not be greater than the benefits, the district will be organized and commissioners directed to proceed with the levying of assessments and construction of the work as proposed in the plans. Said commissioners employ a competent engineer and such other help as may be required. Under this act the commissioners are authorized to construct and maintain ditches and levees and pumping stations wherever such may be required. There are three commissioners appointed by the court and after the district is organized permanent commissioners are appointed to serve for one, two and three years, after which one commissioner is appointed annually to serve for three years. These commissioners report to and are subject to the orders of the County Court in all matters pertaining to the construction and maintenance of the work of the proposed drainage district. Under the Farm Drainage Act the petition for drainage district is filed with the town clerk of the township in which the proposed drainage district is located and if the land lies in two townships the petition shall be filed with the clerk of the town in which the greater part of the district lies. The highway commissioners are the ex-officio drainage commissioners to pass upon in the organization of the drainage district. If the district be organized the property owners elect three commissioners to serve for one, two and three years respectively and elect one commissioner annually thereafter. Under both laws the land is to be classified according to the benefits and assessments for construction based upon the classification for benefits. The methods of procedure and the rights of the property owners and the authority of the commissioners are in general practice the same under both drainage acts, but in some matters of detail there are material differences which are regarded by some as of advantage in special cases. Generally speaking, it is less difficult to enforce the prompt organization of a drainage district under the Farm Drainage Act wherein the highway commissioners act as the organizing board than under the Drainage and Levee Act, where the County Court has jurisdiction. Under both forms of organization, however, the commissioners who are usually appointed or elected to have charge of the work are interested land owners and in substance become active directors in the drainage corporation. In some states, notably Missouri, any land owner or person interested in any lands or related to any land owner, cannot act as a commissioner of a drainage district. Experience has shown that in Illinois the "interested" drainage commissioner is far more effective and useful as an executive officer than a "disinterested" commissioner. There are numerous small details of both of the Illinois drainage laws which might be amended with benefit to the drainage organization, but upon the whole they form a very satisfactory and practical plan for the organization and maintenance of drainage districts. In order to sustain the theory of this law for the construction of drainage ditches across the lands of others and against the will of others, it has been necessary for the courts to overthrow the principle of the common law and sustain the statutory drainage law. New questions of law are arising from time to time in the drainage practice of Illinois, and both of the drainage laws have been amended from time to time by the various sessions of the legislature.

---

* Paper read before the Iowa Drainage Association, Fort Dodge Meeting, Feb. 11 and 12, 1908.

† Civil Engineer, Peoria, Ill.

Iowa Drainage Laws.—The recent experiences regarding efforts at organizing drainage districts in Iowa are similar to those passed through in the early eighties in Illinois. One great difference lies in the fact that the twenty years of practical experience in drainage districts in Illinois have developed a knowledge and experience which has demonstrated their value and utility, which is being used as a basis for evidence and argument in promoting the drainage sentiment in Iowa. I will not undertake to discuss here in detail the provisions of the Iowa drainage law and the needs in this matter. These questions have been brought before this convention and received its serious consideration.

Geographical and Topographical Conditions.—Speaking, the portion of the earth's surface occupied by the states of Illinois and Iowa is of comparatively recent origin, and the drainage channels have been only partially developed throughout the more level lands. With an abundance of rainfall well distributed throughout the year the flat lands have become marshes and at times of excessive rainfall the wide valleys of the streams become overflowed. These different conditions of overflow, both requiring drainage, furnish problems of a different type. A very large percentage of all of the wet lands in both of the states are comparatively level or slightly rolling, with depressions, which when filled with water form lakes, ponds and shallow marshes. These lands generally lie sufficiently high with reference to the nearest stream or natural water course of any size so that if some artificial channel is constructed through the lower portion of the land the surface waters and the underground waters may be readily drained off into the streams. For this class of drainage, ditching is all that is required for the proper reclamation; ditching in this instance meaning to include open ditches and covered or tile ditches. The other class of wet lands being the bottom lands which are subject to overflow from time to time present a problem which requires a combination of protection from overflow by the flood waters of the stream and the drainage of these lands by adequate ditches. The protection from overflow is accomplished by the building of levees and the drainage by the construction of ditches, in some cases by the addition of pumping plants.

The necessity for pumping plants depends upon the height of the land to be drained as compared with the ordinary level of the water in the stream and the fall or slope of the stream or valley in which the land is located. Many of the smaller streams of Illinois and Iowa have from one foot to five feet of fall per mile and in such cases levees can be constructed with open outlets at the lower end of the levee district and with drainage ditches emptying into the main stream at the lower end of the levee, thereby reclaiming the greater portion of the overflowed lands in the valley. On some streams where the fall is from one inch to three or four inches per mile and the bottom lands are subjected to a high water overflow of from six to ten feet in depth, it becomes necessary to install pumping plants in order to properly drain such lands during periods of long continued high stages in the main stream. Pumping plants are necessary notably along the Illinois River and the Mississippi River.

Development of Drainage Work.—Before drainage districts were organized and the general drainage of the country accomplished all the central portion of Illinois which is now the most fertile and highest priced land in the state consisted of successions of low ridges and shallow depressions varying from a few rods to a mile or more in width, the depressions during the spring and summer months—the planting and growing seasons—being either lakes or swamps impassable and of no value to the owner and a source of malaria and ill health to the inhabitants. Every county in this whole section of the state had large tracts of land which the government could not sell and which were donated to the county as "swamp lands," the proceeds of the sale of such lands to be used for the drainage thereof. Upon the enactment of practical drainage laws the farmers proceeded to the organization of drainage districts both large and small, for the construction of open ditches and for the construction of tile ditches, and they have drained a large portion of the area of the wet lands of Illinois and have reduced the swamps and ponds and sloughs to fertile fields on which abundant crops of corn, oats, wheat and grass are raised from year to year. Public highways have been laid out at frequent intervals and are usable at all seasons of the year, notwithstanding improvements known as hard roads would be of great benefit in many localities. The value of the products of the farms has increased from five to ten fold over the old conditions and the value of the lands themselves has increased from their former prices of $5 to $25 per acre until practically all well drained lands in central Illinois today are worth on an average $150 per acre. Without the benefit which accrued from the drainage, these lands would be as worthless and probably lower priced to-day than they were twenty-five years ago. There were many farmers in Illinois in those days who were poor and who were unable because of the lack of drainage of the lands which they occupied to raise sufficient crops to make a decent living and many of them became poorer and poorer while those conditions lasted until their lands were sold or they were abandoned. The same conditions prevail to some extent on the overflowed bottom lands of the state to the present time. There are many years of low rainfall when good crops are raised upon the wetter lands and upon the overflowed bottom lands. The fact that "dry" years occur from time to time lends some courage and many farmers are lead or compelled to take the gambler's chance. If "wet" he loses, if "dry," he wins.

Wet and Dry Years. Wet and dry years run in cycles, but there is no defined law as to the recurrence. From 1893 to 1901 inclusive was a period of low rainfall in this section of country. The rainfall during many of these years was very much below the normal and for none of the years very much, if any, above the normal. In many places in Illinois the distribution of rainfall during the growing period was such as to result in a practical drouth and many of the farmers of the country were convinced that the drouth was the direct result of the excessive drainage. In the early days a very large portion of the country was covered with water; ponds or sloughs and the evaporation from these ponds and sloughs was supposed to have had a material influence upon the rainfall in the immediate vicinity. During those years the drainage operations came to a practical standstill, and except for the reclamation of some of the overflowed lands in the valleys of the stream by leveeing and ditching there was practically little done in drainage in Illinois. In 1902 there came a change. In the early part of the planting and growing season there was a moderate rainfall and the prospects for crops in the low and undrained lands was exceedingly promising. Excessive rains came in June and continued throughout the remainder of the year. A great deal of the low land was flooded and the crops destroyed; moreover there was so much rain during the harvest that many fields of wheat and oats were destroyed in the shock. Nineteen hundred and three was another wet year and there have been no dry years since. The return of the wet years has increased the demand for the completion of the drainage of all the wet lands in the state and there has been great activity during the past few years. There has probably been as much expended for drainage in Illinois in the last five years as any other equal period. A great deal of attention is now being paid to the reclamation of the bottom lands from overflow and providing adequate drainage therefor. Along the Illinois River, the valley is from two to four miles wide and about twelve levee districts have been formed. There were four or five small levee districts prior to 1902—in the aggregate about 20,000 acres in those districts. Owing to the light and imperfect construction of the levees all but one failed in the flood of 1902. These have all been rebuilt and additional districts organized and building so that by the year 1910 there will be no less than 80,000 acres of Illinois River bottom lands protected by levees, the drainage from all of which lands will have to be pumped when the river is high. On the smaller streams of Illinois, the Sangamon, the Kaskaskia, the Wabash, the Little Wabash, Green River and their principal tributaries, great improvements have been made and are in contemplation. Many of these streams which are very crooked have been and are being straightened and levees built along their banks and drainage ditches constructed to carry the waters to an outlet at the lower end of the levee. These lands are all exceedingly fertile and bring a large profit to those who reclaimed them.

Cost.—The cost of drainage of the Illinois lands has varied greatly. On the flat prairie lands where no water is to be cared for except that which falls directly upon the lands in the drainage district, from $3 to $5 per acre has been found sufficient to provide a drainage system of main ditches and from $6 to $12 per acre additional for complete tile drainage. In many cases the flat lands take the drainage of the higher lands surrounding and this condition is merely a matter of degree. Where there is comparatively small area of high lands which drain upon the low lands and which do not necessarily contribute to the drainage system the cost of main drains has ranged from $5 to $10 per acre. Where it has been necessary to straighten streams of any considerable magnitude the cost has ranged from $10 to $20 per acre, as in the case of the Sangamon Salt Creek and Green River. In these cases main channels were cut about 10 ft. deep and from 40 to 100 ft. wide on the bottom with side slopes of 1 to 1. Along the Illinois River where it is necessary to construct levees which will average from 12 to 15 ft. high, drainage ditches and pumping plants, the cost varies from $20 per acre to $50 per acre for the levees, main drainage system and pumping plant. In no cases so far has the cost been found prohibitive; in other words, these lands which are subject to overflow and now have no productive value but a speculative value of from $5 per acre to $25 per acre can well afford a drainage tax of even as much as $50 per acre, because when drained they will have a productive value equal to the best land in the Mississippi Valley and will produce crop values in corn, wheat, oats and grasses of from $15 to $25 per acre per year.

Drainage Studies.—The Experiment Station of the Iowa State College has rendered an invaluable service to the farmers of the state in having prepared the "Data on Drainage Conditions and Notes and Tables on Drainage Engineering," which have been disseminated for the use of interested parties. A proper theoretical basis for the designing of a drainage system is one of the first essentials and a large amount of the drainage work of any country necessarily falls into the hands of those who have limited personal experience and have had little opportunity of availing themselves of the advice of those who have had sufficient experience to form correct judgments in the design of drainage systems. Recognizing these facts the collection of the data and the preparation of these notes for the use of the farmers and local engineers was therefore very timely and far sighted. Many drainage districts in Illinois have been under the necessity of increasing the size and especially the depth of their main drainage ditches in some cases as often as three or four times. This has been due to conditions which in some cases were beyond the control of the engineers in charge or the owners of the land, and in other cases it has been due to mere ignorance as to the necessary size of drainage ditches. To illustrate, there is a certain district in the central northern portion of Illinois comprising about 30,000 acres of marsh land into which, from practically all sides, flows the drainage of 80,000 acres of other land which is higher. About 20 years ago a drainage district was organized to drain the 30,000 acres of marsh land which at that time was considered to be worth from $1 to $5 per acre. Drainage projects were new and untried in those days to practically all of the land owners. A drainage system which would have been adequate probably would have cost $8 to $10 per acre, which would have been from two to five times the then value of the land. Such a proceeding would have been preposterous to the land owners and in this case the plans of the engineer, which were reasonably adequate for the future needs of the drainage district, were changed upon the hearing by the court so as to reduce the cost to about $3 per acre, and under the changed plans with smaller and shallower ditches the district was organized and the work was carried out. The effect of this was partial drainage. As time went on the lands were brought under cultivation and the inadequacy of the drainage system became apparent and in the 20 years seven separate and distinct assessments for increasing the size of the drainage ditches have been levied and expended and at the present time surveys are being made to enlarge the drainage ditches, which if carried out on a scale adequate to the needs, will cost approximately as much as the entire seven previous assessments, making a total of from $12 to $15 per acre for all assessments. There is a disposition to criticize and condemn those who start drainage projects and build ditches that are too small, but in many cases ditches that are too small are very much better than no ditches at all and the benefit derived from the partial drainage of the land will enable those who own the land to see the further benefit and to be able to pay the additional cost of enlarging and deepening their ditches. In cases where levees are to be built this rule does not apply. If a levee is built it must be built high enough and large enough to be safe from overflow to avoid flooding of the lands and a total loss of crops in case of failure.

Depth of Drainage Ditches.—The necessary depth of main drainage ditches has been one of the great problems. A thorough drainage of the soil about 3 ft. below the surface has proven adequate for the raising of corn and the smaller grains and grasses, but in many localities in order to perfect drainage to this depth in the lands remote from the drainage ditches, depths of from 6 to 8 ft. become necessary in the main ditches, so that there is a consensus of opinion among drainage men that 6 ft. should be a minimum depth for main drainage ditches where the slope of the land towards the ditches is sufficient for the necessary fall in the lateral ditches and tile drains. In many localities the fall which must be secured for the main ditch is approximately 1 ft. per mile and in ditches which are supplied only with water from the immediate territory furnish a favorable place for the growth of water moss, grass and weeds which will retard the flow and ultimately fill up the ditch. Experience has shown that in ditches of even considerable width with a fall of 1 ft. to the mile, grass and moss will grow in the bottom of the ditch and hold the water to a depth of from 2 to 2½ ft. That is to say, if a ditch has a fall of about 1 ft. to the mile and 6 ft. deep, grass and moss will grow up in the bottom of the ditch and hold the ordinary flow of water to a depth of 2 to 2½ ft. in the ditch so that the effective drainage depth is only about 4 ft. In order to avoid this condition in flat districts it is necessary that ditches should be dug deeper and it would seem as if a minimum depth of ditch of about 8 ft. is necessary in flat lands to secure a drainage outlet effective to a depth of 6 ft.

Effect of Drainage on High Water.—The straightening and leveeing of the crooked streams and reclaiming the bottom lands which are overflowed is one of the newer problems which confront the drainage engineer and there are comparatively few reliable data to guide him in his determinations. The hydrographic division of the U. S. Geological Survey has gathered a number of data and is continuing investigations which will be very useful in solving these problems. One of the most serious questions in connection with the leveeing of the low lands along the streams is as to the effect on the high water in such streams by reason of the drainage of the lands in the water shed and also on account of straightening the stream and building levees to prevent the overflow of the bottom lands. The apparent area of channels for the flow of the flood waters is very much reduced by the straightening of the stream and the building of levees and the storage capacity of the valley which is leveed is cut off so that if the same quantities of water should reach the stream in the same length of time and at the same points as under the old conditions the floods would unquestionably be much higher. The direct effect of constructing open ditches on the lands is to bring the surplus rain water to the main stream more quickly, but the under drainage of the lands has the reverse effect; for illustration, suppose that the drainage area of a certain stream was all low, marshy land with the water practically at the surface of the ground. Suppose that during one of the spring months there should be rainfall of about 6 ins., which is normal, and 4 ins. of this should fall in the course of 24 hours, which is not unusual. Suppose that there were main ditches constructed of sufficient size to carry off this surface water about as fast as it would fall and as quickly as it could gather into the ditches, say in the course of two days. The 4 ins. of rainfall would produce an enormous flood from that territory. Assume now that this land was thoroughly tile drained so that the water table had been lowered from 2 to 3 ft. in the soil, that is an average of 2½ ft., and that there was an adequate outlet for the tile drains. We find this tract of land at the beginning of the rainy season thoroughly drained and retaining only sufficient moisture for plant growth. The soil when perfectly dry would have about 50 per cent of voids; that is, when perfectly dry it would absorb one-half of its own volume of water. A loam or clay soil requires about 25 per cent of moisture for the proper growth of grain and grasses and when so drained it will still have a receiving capacity of about 25 per cent of its volume. Referring again to the depth of 2½ ft. of drained soil, 25 per cent of which is available for the temporary storage of excessive rainfall, 25 per cent of 2½ ft. is 7½ ins.; in other words, if the drainage area were perfectly flat and was under-drained with tiles so that all of the water falling upon the surface necessarily found its way to the tile and thence to the main drainage ditches a soil properly drained to a depth of 2½ ft, while still containing storage capacity equal to 7½ ins. of rainfall without flooding the surface. Under these conditions the rainfall would soak into the earth as a sponge and would gradually find its way to the tile drains and thence to the open drains. For these reasons the maximum floods to be expected from heavy rains on thoroughly underdrained land is very much less than the maximum floods from an undrained land with the same rainfall. The conclusion would seem to be that, while the open ditches tend to increase the flood stages or high waters in the larger streams, the tiling of the land will have a counteracting influence which will be greater. I think it is reasonable and will be found to be true that the thorough drainage of our agricultural lands in Illinois and Iowa will tend to reduce the high water stages in ordinary streams and increase the summer low water flow. Of course there will be exceptions, cloud bursts and heavy rainfalls occasionally at such times as the surface of the ground is frozen and comparatively impervious. Under those conditions excessive floods will occur either from lack of time for the rain to enter the soil or from the imperviousness due to the frozen surface.

Necessity of Surveys.—One of the first things which confronts the drainage engineer when called upon to advise or make plans for a system of drainage is the need of necessary information with reference to the slope of the land requiring drainage. It has been one of the most difficult matters to procure the surveys necessary to furnish this information. Farmers generally do not realize the value of carefully made surveys and plans, and when they call an engineer it is generally with the idea that he has some supernatural, intuitive power which will enable him to look over the land and "squint" through his instrument a few times to tell all about it. When an engineer does not measure up to this ideal and insists that he needs a carefully made topographical survey of the lands which are to be drained in order for him to form a proper judgment as to the best location and the necessary size and slope of the various ditches required to drain the lands, he immediately loses his prestige and very frequently loses the job. Consequently in Illinois most of the drainage work has been carried out without a complete and desirable survey. The cost of such surveys appears very large and when the burden of this cost is placed upon a few land owners who are desirous of drainage and who are likely to meet serious opposition in the organization of the drainage district and possibly be defeated, it is not strange that the petitioners have insisted that the plans be made at the least possible cost and it is sometimes to be wondered that so good results have been secured under such unfavorable conditions for the proper scientific study of the problems. In recent years there is a tendency among the Illinois farmers to appreciate proper surveys for the main drainage systems and many of them call in competent engineers to lay out their system of tile drainage and make a plat and record of the drains as constructed. This in later years becomes of inestimable value to the owners of the land in case of any extension of drainage necessary or any stoppage of the drains; the location of the tile is shown upon the plans and can easily be located upon the ground. Moreover a record showing the tile drainage of any farmer is a positive asset at any time when the value of such land is to be ascertained or sales are to be made.

In Iowa the drainage law provides for a survey showing the levels of the land and this is a long step in advance of the practice in Illinois.

Building operations during the month of March were on a larger scale than during the earlier months of the year, though the total value of building permits granted in 47 leading cities, in various parts of the country—$34,228,095—was over 20 million dollars below the total reported for March, 1907. Over 60 per cent of the decrease is accounted for by the partial cessation of building operations in New York City, though Chicago, Philadelphia, Pittsburg, San Francisco, and other large cities likewise report smaller figures than a year ago.

Methods and Costs; Some Old, Some New.

Copying a Blue Print.—It is frequently desirable to copy a blue print upon ordinary paper. There are two good ways in which this may be done. One way consists in laying a piece of carbon paper between the blue print and the paper on which the drawing is to be made, the blue print being on top. Then with a "stylus," or pointed piece of steel, follow every line on the blue print, bearing down on the "stylus" hard enough to cause the carbon paper to leave a mark upon the paper beneath. Another plan is to mount a piece of plate glass horizontally so that an incandescent electric light can be placed beneath it. The blue print is laid on the glass and the paper is laid on the blue print. Then a tracing can be made of the blue print just as if ordinary tracing cloth were used instead of common paper.

Scouring Velocities.—In a paper on sedimentation and its relation to drainage, read before the Illinois Society of Engineers and Surveyors, the following table showing scouring velocities was given:

	Ft. per sec.
For very fine clay	0.40
For very fine sand	0.70
For light vegetable soils	0.83
For sand as coarse as flaxseed	0.91
Moves gravel, size of a pea	1.40
Moves small pebbles	2.52
Moves pebbles 1 in. diameter	3.00
Moves pebbles size of hen's egg	4.15
Begins to wear away shale rock	6.40
Rolls stones 1 ft. in diameter	9.90

In a discussion of the paper it was stated that as the results of several observations during low stages of water in the Coal River, West Virginia, it was found that the fine sand there would move when the velocity of the water was as low as 0.8 ft. per second.

Cost of Placing Reinforcing Steel.—The following data relate to the lining of 7,500 lin. ft. of the South Canal, Uncompahgre Project, Colorado, with a 6-in. layer of reinforced concrete, and are taken from the monthly bulletin of the U. S. Reclamation Service, under whose supervision the work was done. Two sections of the canal are considered, each having side slopes of ½ to 1, one having a bottom width of 8 ft. and a vertical lined depth of 10.5 ft., and the other having a bottom width of 13 ft. and a vertical lined depth of 8.4. Each of these sections requires about 0.6 cu. yd. of concrete per lin. ft. of canal. The total amount of reinforcement placed is 245,085 lin. ft. of ⅜-in. corrugated steel bars, weighing as a whole about 119,140 lbs. The steel was hauled an average distance of 4 miles from the railroad siding to the canal work. One man was employed at placing the steel in the concrete during construction. Labor was paid for at the rate of $0.25 an hour, and teams with drivers at the rate of $0.45 an hour. The cost of superintendence of the hauling and placing of the steel has been included with those items and amounts in each case to 15% of the original costs thereof. The cost of reinforcing steel in the canal lining was as follows:

Distribution of cost.	Cost per lb.	Cost per lin. ft. of bars.	Cost per cu. yd. of concrete.
At factory	0.0245	0.0119	0.648
Freight	0.0043	0.0021	0.114
Hauling	0.0007	0.0003	0.018
Placing	0.0043	0.0021	0.115
Totals	0.0338	0.0164	0.895

Cleaning Out an Old Reservoir.—The George's Hill reservoir, Belmont, Philadelphia, Pa., built in 1869, was cleaned out in 1906, 12,000 cu. yds. of black mud being removed from each of the two basins. Each basin is 280 ft. square and was found to contain about 6 ft. depth of mud at the center and 3 ft. depth at the sides. After the water had been drawn off the mud was allowed to dry out for a week, and then the contractors commenced work by clearing away a sufficient space at the west side of the basin to commence laying a track across the mud, still soft and deep enough for a man to sink out of sight. Planks were laid at intervals of 4 ft. and on these ties were placed and 30-lb. rails for a gage of 2 ft. Cars were then run out on the track, sinking it into the mud, and laborers shoveled into the cars, until gradually the track subsided on the hard gravel bottom, leaving room for the men to work on each side. The track was gradually extended until the center of the basin was traversed, when another track was laid. The cars were hauled to the top of the reservoir up an incline of 27 degrees by means of a 60-h. p. hoisting engine, and when on top were hauled away by horses. About 750 cu. yds. of mud were removed each day.

Daily Report Cards for Road Work.—The road work of Caroline County, Md., is done by supervisors for the election districts, acting under the supervision of a Roads Engineer. Daily reports are made to the Roads Engineer by each supervisor. These reports are made on postcards and show the date, names of men working, time made by each, number of horses, their owners and time made, amount of material used and work done. These cards are filed and used by the engineer on his next inspection trip to check the work done and the materials used. This enables the formation of correct conclusion as to whether or not a supervisor is doing work economically. Cards are also used in checking bills when presented, which, under the law, must be passed by the Engineer before payment. The bills are then charged to the respective districts in which the work was done, all bills being subdivided so as to show how or for what the sums were expended, the principal items being labor, teams, carpenters, lumber, hardware, pipe, feed, machinery, etc. Special postcards with the Road Engineer's address on them are also furnished to Rural Free Delivery carriers, to be used by them in reporting any dangerous or unsafe places in the country roads on their respective routes.

Data on Wood Block Paving.—In 1906 the city of Holyoke, Mass., laid 5,480 sq. yds. of wood block pavement by day labor under the supervision of Mr. James L. Tighe, City Engineer. The cost of the work was $3.19 per sq. yd. on High St., where 4.101 sq. yds. were laid, and $3.08 per sq. yd. on Main St., where 1,379 sq. yds. were laid. On both streets the wood blocks were laid on a 1-3-6-in. concrete base, having an average thickness of 5 ins. The wood blocks cost $39.50 per thousand, delivered on cars, and laid 54 to the square yard. The working organization consisted of the following: A steam roller and an engineer ploughing with 4 men on plough; 20 men and 4 teams excavating with a haul of about ¾ mile on the average, 2 men finishing grading, 2 teams and 6 men hauling stone, 20 men mixing concrete and laying in place (In mixing the concrete there were two platforms with 5 men to a platform.), 2 teams and 3 men hauling sand, 4 men placing and forming cement cushion, 2 pavers laying block, each having 3 tenders, 1 man spreading sand on pavement when laid. The force also included 2 foremen and the superintendent. Common labor was paid $2 per 8-hour day, foremen $3.10 per day, and double teams $4 per day. Broken stone cost 90 cents per ton delivered on cars, Portland cement cost $1.67 per bbl. delivered on cars, and sand cost 10 cents per cu. yd., not including haulage, which was about 4,000 ft. on the average.

The Italian government is contemplating the construction of drainage works and improvements in the Pontine marshes, which will involve the expenditure of about $12,000,000.

The total amount of material excavated in the Culebra division of the Isthmian Canal during the month of March was 1,295,205 cu. yds., an increase of 46,940 cu. yds. over the amount excavated in February. Of this amount, 1,216,264 cu. yds. were removed from the Canal prism, and 74,621 cu. yds. were taken from the Camacho and Obispo diversions.

Edson Diaphram Trench Pumps

THE EDSON PUMP

was the FIRST DIAPHRAGM PUMP ever made. Experience counts for something. IT is the accepted STANDARD all over the world.

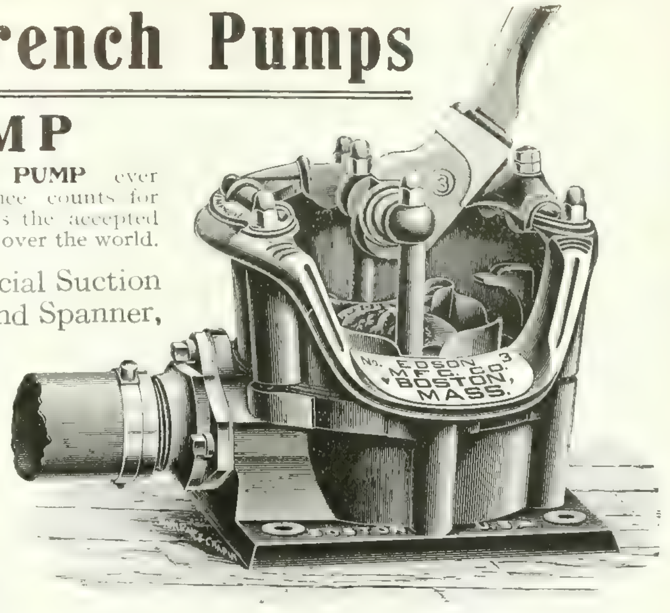
Complete Outfits, including Pump, Edson Special Suction Hose, Extra heavy Brass Couplings, Strainer and Spanner, **ready for business.** Extra lengths of **Suction Hose,** guaranteed **Diaphragms** and duplicate Pump parts, **carried in stock.**

SEND FOR DESCRIPTIVE CATALOG

Established 1859

EDSON MFG. CO.

256 Atlantic Avenue Boston, Mass.


No. 3
EDSON MFG. CO.
BOSTON, MASS.

ARE YOU INTERESTED

in any tools, supplies or machinery, or books on any subject? If you are in the market for ANYTHING send us a postal card and we will notify the leading dealers or manufacturers. No matter what it is, just TELL US.

ENGINEERING-CONTRACTING.

WHAT'S THE USE

putting up with old style wooden cars, scrapers, etc., that are slow, unwieldy and expensive to operate when

YOU CAN RENT

a Koppel Portable Railway and Equipment either by the month or contract on reasonable terms?

You can do twice the work in half the time and at half the cost if you use Koppel equipment.

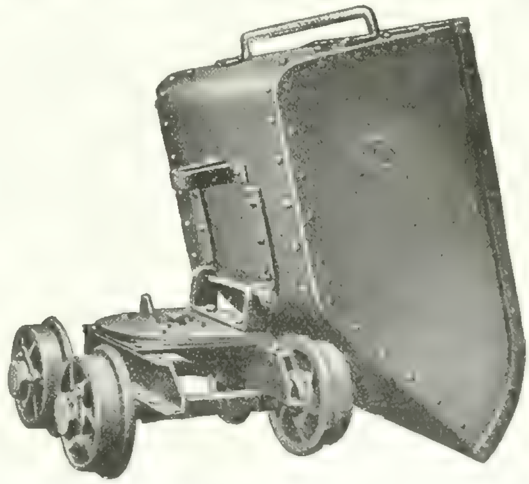
WRITE FOR RENTING LIST E.

ARTHUR KOPPEL COMPANY

NEW YORK 139 Morris Bldg.	CHICAGO 341D Monadnock Bldg.	BOSTON 53 Oliver St.
PITTSBURGH 1610 Machesney Bldg.	SAN FRANCISCO 1511a Chronicle Bldg.	BALTIMORE 149 Equitable Bldg.

Contractors' Rotary Dump Concrete Car

This is only one of our specialties. We manufacture CARS for Concrete, Gravel, Sand, Stone, Brick. Also all kinds of ELEVATOR BUCKETS,



ELEVATORS, REVOLVING SCREENS, BOTTOM DUMP BUCKETS, WHEELBARROWS and CONCRETE CARTS.

If you need any of the above write us for prices and CATALOG EC No. 10, we can quote you the lowest and give A No. 1 goods.

H. B. SACKETT SCREEN & CHUTE CO.

4214-4228 State Street, CHICAGO

WANTS

Undisplayed Cards under this heading cost only

One Cent a Word

Displayed $1.00 an Inch.

TECHNICAL MEN superintendents, engineers and draftsmen. Openings in all parts of the world at the highest possible salaries. Write us today of your experience. Hapgoods, 305 Broadway, New York City, or Suite 1012 Hartford Building, Chicago.

WANTED—At once, an assistant electrical and steam engineer. A good position to the right man. Postum Cereal Co., Ltd., Battle Creek, Mich.

WANTED—Young man, technical graduate, experienced in concrete construction, desires position in designing, estimating, etc., for contractor, or consulting engineer. Address Box 30, care Engineering-Contracting, 355 Dearborn St., Chicago. 19-2t

BUILDING FOREMAN WANTED—By owner; hustler, about thirty. Must invest $5,000-$10,000 during employment. Address "Box 25," care Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Technical graduate with 14 years' experience as constructing engineer in charge of large hydraulic and steel construction desires to change position. Address "Box 24," care of Engineering-Contracting, 355 Dearborn St., Chicago. 16-4t

WANTED—Position as assistant to contractor, or as general foreman. Am civil engineer, 32 years of age, with 12 years' experience in railroad, sewer, road, concrete and masonry construction. Address "T. S.," 3716 Ellis Ave., Chicago, Ill. 18-3t

WANTED—POSITION—Young Civil Engineer, technical education, experienced on Railroad Preliminary Location and Construction. Heavy Masonry and general work wants position. Address "P. P.," care of Engineering-Contracting, 355 Dearborn St., Chicago. 3-tf

WANTED—POSITION by contractor's superintendent in general work. 25 years' experience in tropics and United States. Go anywhere. Open in June. First-class references. Address Box H, care of Engineering-Contracting, 13-21 Park Row, New York. 20-1t

WANTED—Position. Young man now employed, age 26. Good salesman and solicitor, having seven years' experience with engineers and contractors, desires permanent position in sales department of reliable firm handling contractors' supplies or a general line of construction material. Address Box 33, care of Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Position by Civil Engineer, 27 years old. Specialty reinforced concrete. Employed at present time. Graduate of one of the best Universities in Europe. Four year's experience in drafting, design, estimating and construction work. Inside position preferred. Best of references. Least salary considered $120 a month. Address Box 31, care of Engineering-Contracting, 355 Dearborn St., Chicago. 19-2t

WANTED—Partner who can invest $15,000 in a Manufacturing plant. One who is familiar with the sales of Concrete Machinery preferred. This plant with stock on hand at present will inventory $35,000. Parties who own the patents on Mixers and who now own plant cannot carry on business without additional capital and will sell half interest to party who is prepared to hustle for sales. Address "Box 26," care Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—POSITION—As superintendent, or general foreman on large construction work. Ten years' experience on public work. Experienced in excavation, earth and rock; heavy concrete construction, piers, abutments, retaining walls, dams, etc.; transportation of materials, etc. Possess executive ability to supervise large bodies of men; have handled successfully nearly every kind of labor used in the United States. At present employed: 32 years of age. Unmarried. First-class references. Address Box 29, care of Engineering-Contracting, 355 Dearborn St., Chicago. 18-3t

Wanted to Buy

THEW STEAM SHOVEL

Address Box 32, care of Engineering-Contracting, Chicago, stating price and giving size of shovel.

FOR RENT

TWO K & E TRANSITS

Good Condition.

$8 a month to responsible parties.

D. B. METCALF,

48 Mt Morris Bank, 125th Street, New York

STUDY OUR

CONCRETE

COURSES

Reinforced Concrete Design; Concrete Construction and Contracting, Plain and Rein=forced; Manufacture of Cement Products, i. e. Blocks, Brick, Etc.

THESE courses are all meritorious. The latter teaches a new and scientific method of making concrete blocks, that gives as low as 4 per cent absorption and remarkable strength. Such blocks will win the favor of engineers; the cost is practically no higher. FREE CATALOG explains. Please indicate the course you are interested in.

CONCRETE ENGINEERING

584 Caxton Bldg., Cleveland

FOR SALE

1 Kearns **Revolving Excavator,** 1½ yard Orange-Peel Bucket, 65 ft. boom.

Two 36″ gauge **Saddle Tank Locomotives,** 12 ton.

One 15 ton, 36″ gauge **Saddle Tank Locomotive.**

New light rails and standard section **relayers** of all weights.

BLOCK=POLLAK IRON CO.,

Chicago **Cincinnati** **St. Louis**

Yards, East Chicago, Indiana

FOR SALE

Five-ton Northern, standard gauge, full circle

LOCOMOTIVE CRANE

with 25 ft. boom, now being rebuilt at Chicago shops and arranged to handle small clam or orange peel.

Ready about April 15th.
Will be good as new.

WILLIS SHAW

171 La Salle Street, Chicago

ESTABLISHED 1820

YOUNG & SONS

MANUFACTURERS OF

ENGINEERING MINING AND SURVEYING INSTRUMENTS

PHILADELPHIA

J. F. GRAHAM

(Roadmaster Graham)

RAILROAD LABOR AGENT

All classes of Laborers in Any Number

SUPPLIED FREE

Competent Foremen a Specialty.
Services Guaranteed Satisfactory.

WRITE OR WIRE

204 Washington Avenue South

MINNEAPOLIS, MINN.

CONTRACTORS AND ENGINEERS

SAVE LABOR

USE

Nash's Expeditious Measurer

A book of 200 pages of indexed tables, showing at a glance the cubic contents of any stone or package according to its length, breadth and depth. Used by Contractors, Quarrymen and Engineers everywhere. Order of your bookseller or the publisher. **$2.00 Postpaid.**

A. L. NASH

17 State Street NEW YORK

Send for Sample Pages

SAVE TIME

AVOID ERRORS

FOR SALE OR RENT

Two Vulcan **shovels,** 1¼ yard and 2½ yard, 3 sets engines.

Two 42″ gauge saddle tank 9 x 14, **locomotives,** saddle tank.

Two 36″ gauge **locomotives,** saddle tank, 9 x 14.

30 and 56 lb. **relayers** with plates.

Traction engines, hoisting engines, pumps, etc.

HARPER MACHINERY COMPANY

1861 Fulton Bldg., Hudson Terminals,
50 Church Street, New York
Yards and Shops, Bloomfield N. J.

FOR SALE

1 Carson **Trench Machine.** Fine condition. Cost new $3,000.00. Will sell for..................	**$1,700**
1 ¾-yd. Smith **Mixer** on trucks, with engine.	
10 1-yd. K. & J. **Scrapers.** Fine shape.	
2 1½-yd. Oliver rotary **Cars.** Cheap.	
1 8-wheel **Locomotive,** just overhauled and in fine condition. Price.....	**$2,000**

Write us for anything you may be needing in the line of Contractors' equipment.

R. G. LUCAS & CO.

MARION, OHIO.

Engineering-Contracting Monthly Review Index.

A Bibliography of Civil Engineering Literature.

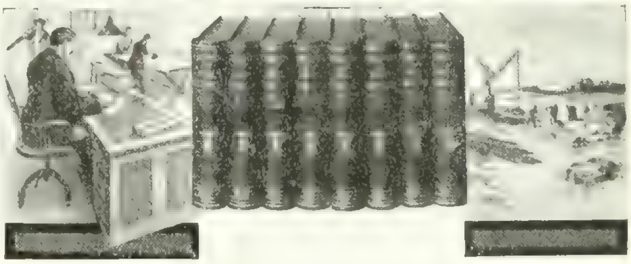
THE **Monthly Review Index** of civil engineering literature is a new feature of ENGINEERING-CONTRACTING for 1908. This index contains reviews of all the best engineering books published each month. It also indexes and reviews every article of distinctive merit and practical value that is published in any of the several scores of engineering papers received and filed in both our Chicago and our New York offices. Articles of interest to civil engineers and contractors only are reviewed. These articles are *reviewed*, not merely indexed or listed, that is, *digests of their contents are given* with explanatory comment. By reason of this rigid selection and painstaking analysis the **Monthly Review Index** becomes a high class bibliography of civil engineering literature. It gives the civil engineer and contractor each month a classified digest of the most reliable and useful articles that have appeared in print during the month on civil engineering and contracting work. The reader is told where and how to secure each article and what it will cost him. He is told what the article contains; whether it is general or specific; whether it relates to design or construction; whether it gives methods and costs or does not. Each item is so printed that it can be clipped and pasted onto a library index card for permanent filing.

The **Monthly Review Index** forms a separate section of from six to eight pages of ENGINEERING-CONTRACTING for the first issue of each month. It is a part of the regular edition of and is included in the regular subscription price for ENGINEERING-CONTRACTING, which is $2 for 52 issues.

For a limited time we are accepting new subscriptions and renewals at $1 a year or $5 for five years. (Double price to Canada.)

ENGINEERING-CONTRACTING
355 Dearborn Street, Chicago

The Great Divide



KNOWLEDGE IS THE GREAT DIVIDE BETWEEN THE MAN WHO WORKS AND THE MAN WHO PLANS. The Civil Engineer is, above all others, the pioneer of progress. Few people have any idea how wide is the field of work allotted to him. That field includes almost every phase of our industrial, commercial, municipal and national life, and almost every measure affecting public health, comfort or convenience

CYCLOPEDIA OF CIVIL ENGINEERING

8 VOLUMES. Page size, 7x10 inches. 3,500 pages.
3,000 illustrations, diagrams, plates, formulas, etc.
BOUND IN HALF RED MOROCCO.

This is the first great reference work ever compiled covering the entire field of Civil Engineering with all its allied branches, such as surveying, map making railroad engineering, road building, masonry, steel and reinforced concrete structural engineering, bridge design and construction, river and harbor improvement, water supply, irrigation, water power development, sanitary engineering, including sewerage, plumbing, house drainage and sanitation, etc

THE CIVIL ENGINEER who wishes to "brush up" on his weak points or get in touch with all the latest developments in the engineering field can find no better method than by referring to this great work.

THE STUDENT who is not advancing as rapidly as he wishes can cut much time from his course and greatly increase his knowledge by a close study of these eight big money making volumes.

Special ADVANCE Offer

RESERVE set now. Sent express prepaid for 5 days' FREE examination. $2 to be paid within 5 days and $2 a month until you have paid the special price of $24. Regular price is $48. We send for books at our expense if not wanted.

The work represents the combined efforts of a large staff of practical experts. It is admirably adapted to the needs of the beginner and self-taught practical man in addition to meeting all demands of the technically trained expert. The various sections have been prepared especially for HOME STUDY. Heavy technicalities and mathematical formulas have been avoided wherever possible without sacrificing the absolute requirements of practical instruction. The language is clear and simple, the treatment concise, yet exhaustive, and the arrangement of matter convenient so as to carry the reader forward by easy stages. Series of test questions are inserted at the end of each section, enabling the reader to test his knowledge as he studies, thus combining the advantages of a text book and a reference work

BRIEF SYNOPSIS OF CONTENTS

Plane Surveying Land Surveys, Mechanical Drawing—Lettering, Blue Printing; Plotting and Topography; Railroad Engineering—Curves, Tunnels, Trestles, Culverts, Switches, Terminals; Graphic Statics; Strength of Materials; Roof Trusses; Masonry Construction—Pile Foundations; Reinforced Concrete; Steel Construction—Fire Proofing, Floor and Roof Arches, Skyscrapers; Practical Problems in Construction; Bridge Engineering—Bridge Analysis and Design, Girder and Truss Spans; Highway Construction—Grading, Pavements; Hydraulics—Pressure of Water, Measurement of Flow; Water Supply—Water Works, Wells, Reservoirs and Dams, [illegible]ation; Irrigation—Gravity Irrigation, Pumping Systems And Lands; Water Power Development—Diversion of Water, Reservoirs, Flumes, Tunnels, Turbines, Water Wheels, Power Plants; Sewers and Drains—House Connections, Sewage Disposal; House Drainage and Sanitation—Plumbing, Pipes and Connections.

AMERICAN SCHOOL OF CORRESPONDENCE
CHICAGO

COUPON. Clip and Mail To-day

American School of Correspondence Eng.-Con. 5-13-08

Please send set Cyclopedia of Civil Engineering for 5 days' free examination. I will send $2 within 5 days and $2 a month until I have paid $24.00, otherwise I will notify you to send for the books.

Name .....

Address .....

Occupation .

Employer

JUST PUBLISHED

Concrete Construction--Methods and Cost

BY

HALBERT P. GILLETTE
M. Am. Soc. C. E., M. Inst. M. E.,
Managing Editor *Engineering-Contracting*

AND

CHARLES S. HILL, C. E.
Associate Editor *Engineering-Contracting*

THIS book tells how to build concrete structures and what such work costs. The methods described and the cost data given are taken from actual records of construction engineers and contractors. They cover all kinds of concrete work, both plain and reinforced – sidewalks, pavement base, bridges, buildings, sewers, aqueducts, reservoirs, retaining walls, dams, abutments, piers, breakwaters, pile foundations, and all other structures for which concrete is used. They also give data on quarrying and crushing stone, washing and screening sand and gravel, doing work in freezing weather, rubble and asphaltic concrete, ornament molding, proportioning and mixing, finishing concrete surfaces, and miscellaneous operations. **The book occupies a field by itself**—the field of methods and costs of concrete work.

THE designing engineer who wishes to analyze the effect of design on cost and speed of construction; the constructing engineer who desires to know whether economic and efficient methods of work are being followed; the contractor who wishes to check costs, seek out wastes and institute economies will find the data given in this book invaluable. It is a comprehensive and carefully prepared treatise on the economics of concrete construction.

The book has 700 pages and 306 illustrations of forms, tools, machinery, etc., used in concrete construction.

Price, $5 Net, Postpaid

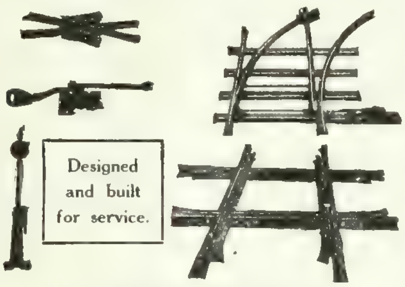
Write for 16-page pamphlet showing table of contents and sample pages.

The Myron C. Clark Publishing Co.

13-21 PARK ROW, NEW YORK
355 DEARBORN STREET, CHICAGO

The Cincinnati Frog & Switch Co.
CINCINNATI, OHIO
Manufacturers of
Frogs, Crossings, Switches, Switch Stands, Rail Braces,
And special track work of every description for Railroads, Mines, Mills, Contractors, Plantations.

FROGS, SWITCHES, CROSSINGS
Stands and Portable Track for all weights of rail for Quarries, Mines, Coal Tipples, Industrial Plants and Contractors' use.



Designed and built for service.

Catalogue and prices upon request
THE INDIANAPOLIS SWITCH & FROG CO.
SPRINGFIELD, OHIO

RARE BARGAINS in RAILS and EQUIPMENT
WALTER A. "ZELNICKER" SUPPLY CO.
in ST. LOUIS
Do you receive our Stock Lists?

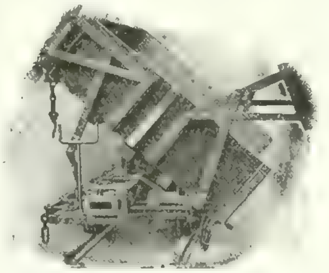
LOCOMOTIVES
Eight 9x14 saddle tank 36-inch gauge. Also lighter and heavier locomotives. Have 165 locomotives from 6 to 70 tons in stock in our shops.
Also Steam Shovels
Southern Iron & Equipment Co.
ATLANTA, GA.

Largest Dealers in Rebuilt Equipment in United States
EAST WORKS
New Freight and Passenger Cars
WEST WORKS
Rebuilt Coaches, Cars and Engines
Hicks Locomotive & Car Works
General Offices Chicago Heights, Illinois
Sales Dept. Fisher Building, Chicago, Ill.
Eastern Representatives Empire Steel & Equipment Co., 141 Broadway, New York.

Steam Shovels, Locomotives, Cars, Etc.
Contractors' and Railway Equipment
Telegraph, Telephone or Write Us.
A. C. TORBERT & CO.
547-548 Monadnock Block CHICAGO

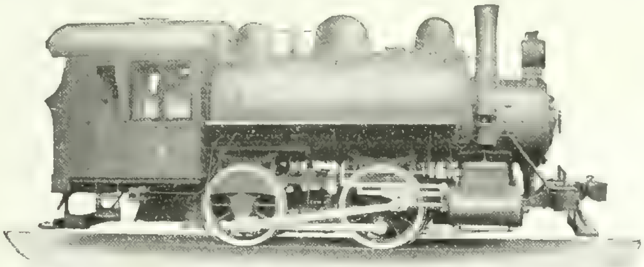
VULCAN IRON WORKS
CHICAGO
PILE DRIVERS

"CONTINENTAL" DUMP CARS



1½ to 20 Cubic Yards Capacity, any Gauge.
Continental Car & Equipment Co., (Inc.)
17 Battery Place, New York
Highland Park, Louisville, Ky.

LIGHT LOCOMOTIVES



For contractors, mines, plantations, industrial plants and light switching service generally.

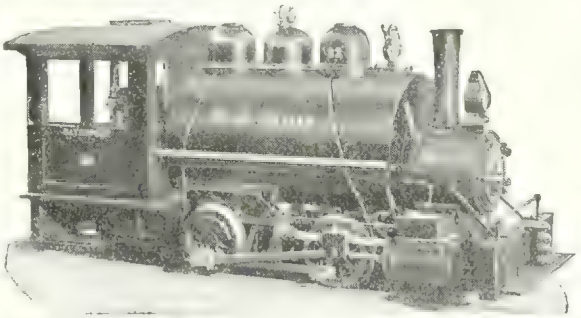
Standard types in stock for immediate shipment. Any desired design built to suit purchasers' requirements.

Interchangeable spare parts always on hand.

AMERICAN LOCOMOTIVE COMPANY
111 Broadway, New York

Davenport Contractors' Locomotives
Excel in Hauling Capacity as well as in working and wearing qualities—That's why so many contractors use them exclusively

We build a contractor's locomotive—not merely a locomotive that can be used by contractors. This being our business, we have made it a point *to learn* by study and experiment the things that a contractor wants in a locomotive, and after learning, *to provide* these needed things in **Our Locomotive.** A contractor's locomotive has hard usage, and not the best care—good material and good workmanship are, therefore, essential, and we provide both. A contractor's locomotive must have hauling capacity—we guarantee **Davenport Locomotives** to haul more, size for size of cylinders, than any other. A contractor's locomotive has to be simple and easy to repair — **Davenport Locomotives** have interchangeable parts, and these parts are always kept in stock. We demonstrate all these claims in our Catalog "EC." Send for it, and if you are ever in Davenport come and see our plant—we feel proud of it.



DAVENPORT LOCOMOTIVE WORKS, Davenport, Iowa

List of Contractors' Supplies.

If you wish the catalogs of the leading manufacturers of any tool or machine mentioned below, send us a postal card, giving your address and business, and the list number of article of which you want catalogs.

This will save you the trouble of writing several letters to different manufacturers. Should you later on have correspondence direct with the manufacturers, we shall apppreciate it if you will state in your letters that you are indebted to Engineering-Contracting for the introduction. Such a statement will be mutually beneficial.

2 Asbestos.
4 Asphalt.
6 Asphalt plants.
7 Asphalt tools.
8 Augers, pneumatic.

10 Ballast spreaders.
12 Balast unloaders.
14 Bearing, ball and roller.
16 Bearings, self-oiling.
18 Bellows.
20 Belt dressing.
22 Belting, canvas.
24 Belting, chain.
26 Belting, leather.
28 Belting, rubber.
30 Blacksmiths' tools.
31 Blasting batteries.
32 Block machines, cement and concrete.
33 Blocks, tackle.
Blowers. See 180.
36 Blue print machines.
38 Boilers.
39 Boiler covering.
40 Brakes, air.
42 Brick, building.
44 Brick, paving.
45 Brick machines.
46 Bridges.
48 Buckets, clam shell.
50 Buckets, dumping.
52 Buckets, orange peel.

60 Cableways.
62 Cars, ballast.
64 Cars, dump.
66 Cars, flat.
68 Cars, hand.
69 Cars, mining.
70 Carts. See also 520.
72 Carts, concrete.
73 Castings, brass.
74 Castings, iron.
76 Castings, steel.
Cement block mach. See 32
80 Cement pipe molds.
82 Cement walk tools.
84 Cement, natural.
86 Cement, Portland.
88 Chains, common.
90 Chains, sprocket.
91 Channelers.
92 Clocks, time.
93 Chimney construction.
94 Compressors, air.
95 Conduit, bituminous fiber.
Concrete reinf. See 474.
Conduit, vitrified. See 142.
96 Concrete fence post molds.
97 Computing machines.
98 Contractors' bonds.
100 Contractors' supplies.
102 Conveying machinery.
104 Cranes.
106 Cranes, locomotive.
108 Cranes, traveling.
110 Creosoting.
112 Crossings, railway.
114 Crushers, rock.
116 Culverts.

120 Derricks and fittings.
Draftmen's instrs. See 154.
124 Dredges.
126 Drill sharpeners.
Drills, air. See 136.
128 Drills, core.
130 Drills, diamond.
132 Drills, pneumatic plug.
134 Drills, ratchet.
136 Drills, rock.
138 Drills, well.
140 Dynamite.
142 Ducts, vitrified.
Dump wagons. See 520.
144 Dynamos.

Electric motors. See 324.
152 Elevators, bucket.
154 Engineers' instruments.
156 Engines.
158 Engines, gas.
160 Engines, gasoline.
162 Engines, hoisting.
164 Engines, steam.
166 Engines, traction.
167 Expansion bolts.
168 Expanded metal.
169 Expanders, tube.
170 Exploders.
172 Explosives.

180 Fans or blowers.
182 Felt.
184 Fence and railing.
186 Filters, water.
187 Fireproof doors, partitions.
188 Flanges, steel.
190 Flue lining.
192 Flush tanks.
194 Forges, blacksmith.
195 Forms for concrete work.
196 Frogs.
198 Fuel economizers.
Fuse. See 170.

210 Garbage furnaces.
212 Gates and valves.
214 Gears and pinions.
216 Governors, engine.
218 Governors, water wheel.
220 Graders, elevating.
222 Gaskets.
224 Grubbers.

228 Hammers, pneumatic.
230 Hangers, joist.
232 Harness.
234 Hoists, air.
236 Hoists, chain, differential.
238 Hoists, electric.
240 Hoists, gasoline.
242 Hoists, horse-whim.
244 Hoists, steam.
246 Horse feed-bags.
248 Hose.
250 Hydrants.

260 Injectors.
261 Insulated wire.
262 Iron.
264 Iron, corrugated.
266 Iron, sheet.

270 Jacks, hydraulic.
272 Jacks, screw.
274 Jacks, track.
Jacks, trench. See 502.

280 Laborers supplied.
282 Lamp posts.
284 Lathe, metal.
286 Lights, contractors'.
288 Lime.
290 Locomotives, dinkey.
292 Locomotives, electric.
294 Locomotives, gasoline.
296 Locomotives, geared.
298 Locomotives, steam.
300 Lubricants.
302 Lumber, creosoted.

310 Machine tools.
312 Manganese steel.
314 Manhole covers.
315 Metaline.
316 Meters, water.
318 Mineral wool.
319 Mining machinery.
320 Mixers, concrete.
322 Motors, compressed air.
324 Motors, electric.
326 Motors, water.

330 Nickel steel.
332 Nuts and nut locks.

330 Oilless Bearings.

340 Packing.
341 Painting machines.
342 Paints.
344 Paving blocks, stone.
Paving bricks. See 44.
348 Picks.
350 Pile drivers.
352 Pile driver jets.
354 Piles, concrete.
356 Piles, interlocking, steel.
358 Piles, creosoted.
360 Pipe covering.
362 Pipe, cast iron.
364 Pipe, cement.
366 Pipe, lead.
368 Pipe, riveted steel.
370 Pipe, vitrified sewer.
372 Pipe, wrought iron.
374 Pipe cutting machine.
375 Pipe tapping machines.
376 Plows.
Plows, unloading. See 12.
Pneumatic tools. See 8, 132, 416.
380 Portable railways.
382 Powder, black.
383 Prism glass.
384 Pulleys.
386 Pumps, diaphragm.
388 Pumps, electric.
392 Pumps, sand.
394 Pumps, steam.
396 Pumps, trench.
398 Punches, hydraulic.
400 Quarry bars.

406 Railroad signals.
410 Rails, new.
412 Rails, second hand.
413 Railway track layers.
414 Rammers, pneumatic.
415 Recording instruments.
416 Riveters, pneumatic.
418 Road machinery.
Rock crushers. See 114.
422 Rollers, horse.
424 Rollers, steam.
425 Roofers' supplies.
426 Roofing.
427 Rope drive.
428 Rope, manila.
430 Rope, wire.

438 Sand blast apparatus.
Sand pump. See 392.
440 Saw mills, portable.
Scale box. See 462.
442 Scarifiers for macadam.
444 Scrapers, drag.
446 Scrapers, road.
Scrapers, wheel. See 528.
448 Screens, rotary.
450 Second hand outfits.
Sewer braces. See 502.
454 Sewer cleaners.
455 Sewer traps.
Sewer pipe. See pipe.
457 Shafting.
458 Sheaves.
460 Shovels, hand.
462 Skips.
464 Slate.
466 Sprinkling carts.
468 Standpipes.
470 Steam shovels.
472 Steel, structural.
474 Steel for reinf. concrete.
476 Stone, broken.
478 Stone dressing mach's.
479 Street sweepers.
480 Stump puller.
482 Switches.

490 Tanks, water.
491 Tapes, measuring.
Tapping mach's. See 375.
492 Tar.
494 Tents.
496 Ties, steel.
498 Tile.
Time keeping devices. See 92.
Traction engines. See 166.
Track laying mach. See 413.
499 Track tools.
500 Tracing cloth.
502 Trench braces.
504 Trench machines.
506 Turntables.

510 Valves, steam.
512 Valves, water.
513 Vault lights.
514 Ventilators.

520 Wagons, dump.
522 Waterproofing.
Well drills. See 138.
526 Wheelbarrows.
528 Wheel scrapers.
530 Windmills.
532 Wire cloth.
Wire rope. See 430.

The above is only a partial list of the headings in our Card Index. No matter what you want, TELL US and we will put you in prompt communication with the leading manufacturers, dealers or contractors.

USE THE

"Blaw System"

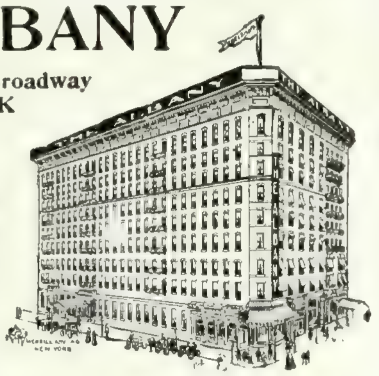
for centering your
concrete structures.

Write for CATALOG

**BLAW COLLAPSIBLE
STEEL CENTERING CO.**

General Offices:
Westinghouse Building
PITTSBURG, PA.

CHICAGO OFFICE: 1005 Chamber of Commerce Bldg.
NEW YORK OFFICE: 320 Park Row Bldg.



Remodeled, Handsomely Furnished New Throughout

THE ALBANY

41st Street and Broadway
NEW YORK

ABSOLUTELY FIREPROOF

In the heart of the City

500 Rooms 300 Bath Rooms

European Plan. Cuisine Unexcelled. Gentlemen's Cafe Ladies Restaurant and Moorish Rooms Popular Prices. Plenty of life—but home-like. Single Room and Suites with and without Bath.

$1.00 per Day and up

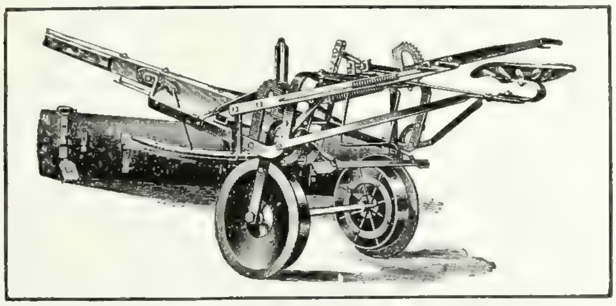
Send for Booklet

ROBERT P. MURPHY

This One-Man Grader Saves a Third to a Half

REASONS are numerous why the 20th Century Grader is a horse-flesh saver, an economizer of time, a preventer of worry and anxiety—600 pounds is light for so strong a machine which takes the place, (in three-quarters of the instances) of the two-ton, clumsy grader. What's the use of killing your horses when one man and a team can do the work quicker and easier, without the horses tearing out their insides.

Our 1908 Model has several unique and noteworthy features found on no other grader. Among them; flanged wheels, lever side-adjustment for pitch of blade, adjustable shoes on mold-board, etc. These and a score of other good reasons why you should own and operate a



20th Century Grader

are told in our brand new booklet printed in orange and black, entitled, "20th Century Highways." This book tells how to make good roads out of bad ones, enumerates all the uses to which the 20th Century Grader can be put in constructing roads, railroad grades, irrigation ditches, for digging foundations for pavements, for leveling lawns, fields, etc., etc. It's valuable. Send now for it. It's free. Address

The Baker Manufacturing Co.
Dept. F, 706 Fisher Bldg. CHICAGO

American Society of Engineering-Contractors

Early last year, Halbert P. Gillette, Managing Editor of this journal, issued a call to contractors and engineers, asking them to join in forming an American Society of Engineering Contractors. Mr. Gillette agreed to act as chairman and secretary of the Society, *pro tem*, and in that capacity has already received over 900 applications for charter membership. The experimental stage is past, and a large membership of influential men is now assured. We urge every contractor and every engineer to join this great national organization. One of the main objects of the society is to secure uniform and equitable general clauses in engineering specifications. Another object is to combat the inefficient "day-labor system" of doing public work, and to educate the public to the true economy of doing all work by contract. A third object is to have a voice in the solving of all social problems affecting the welfare of contractors and engineers, such as the problems raised by labor unions. A fourth object is to exchange ideas on the management of men, the operation of machinery, the keeping of cost records, and such other business as would naturally come before a national organization of this character. If you have not already applied for membership, do so on the accompanying blank; and then urge your friends to join.

HALBERT P. GILLETTE,
Park Row Bldg., New York

DEAR SIR:

I am desirous of becoming a charter member of the American Society of Engineering-Contractors, provided the dues and conditions of membership shall prove satisfactory to me when they shall be decided upon.

Name..

Occupation ....

....

____

Go Into Road Contracting

AND

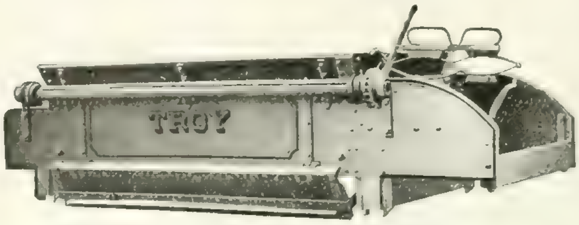
Build Petrolithic Roads.

A number of engineers and contractors have recently abandoned all other work and are making a specialty of building Petrolithic roads and streets. Real estate men who are laying out suburban tracts are eager to get a cheap, dustless pavement, and are easily persuaded to use Petrolithic. Once it has been used in any locality, repeat orders are secured, and a profitable business is quickly established. Country roads can be made by the Petrolithic process at less cost than macadam, and they are dustless, even under automobile traffic. By mixing asphaltic oil, Tarvia, or any suitable bituminous product with the natural soil, and by consolidating with a Petrolithic roller, a roadway is produced, that is superior to any other, and at very low cost. It will pay you to investigate. To do so, begin by sending for our new catalog.

Petrolithic Pavement Company

764 Pacific Electric Bldg. Los Angeles, Cal.

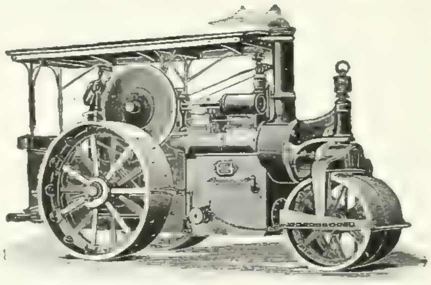
A MISTAKE commonly made by contractors and engineers is to glance at an advertisement and postpone getting the catalog that gives a more complete description. In this small space we can not give, for example, a view of the Troy Dump Box looking down on it from above. Yet that view shows several important differences from other dump boxes. For example, there are no chains or rods that run across the bottom of the Troy Dump Box, clogging the free escape of the material when it is dumped. Do not wait until the last moment to investigate the merits of the Troy Dump Box, but send for our BULLETIN E, now, and, among other things, learn why the Troy Dump Box fits any wagon gear.



The Troy Wagon Works Co.

295 South Walnut Street TROY, OHIO

KELLY-SPRINGFIELD ROAD ROLLER CO.



Steam Road Rollers, Over Eighteen Hundred in Use.

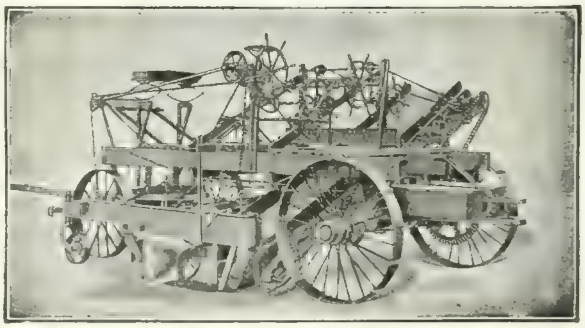
All Types, All Sizes, Satisfaction Guaranteed.

Send for Catalogue No. 4

SPRINGFIELD, O.

PHILADELPHIA OFFICE, 2132 LAND TITLE BUILDING

NATIONAL ELEVATING GRADER



Send for Catalogue EC

INDIANA ROAD MACHINE COMPANY

FORT WAYNE, IND.

Some Advantages of

Creosoted Wood Paving Blocks

Smooth as Asphalt.

Durable as Granite Blocks.

Sanitary on Account of antiseptic treatment.

Noiseless to a greater extent than any other pavement.

Appeals to tax payers and contractors alike.

Capacity 3,000,000 yards a year.

Ayer & Lord Tie Company
1123—138 Washington Street
CHICAGO, ILL.

FRANK C. POWERS, Sales Agent

THERE IS ONLY ONE

Bitulithic Pavement, and that one is the Durable, Dustless, Sanitary and Non-Slippery street surface prepared and laid under the patented formulae and processes of Warren Brothers Company.

Bitulithic is the one smooth pavement that stands for Uniformity and Quality. It is the Ideal Roadway.

FULL INFORMATION FOR THE ASKING.

WARREN BROTHERS COMPANY
BOSTON, MASSACHUSETTS

"Bitulithic" "Puritan" Registered Trade Marks "Bituminous Macadam" "Bitrock" "Bitustone"

GULF REFINING CO.

REFINER OF

Indian Territory and Texas Petroleum

MANUFACTURER OF

ASPHALT for PAVING and ROOFING

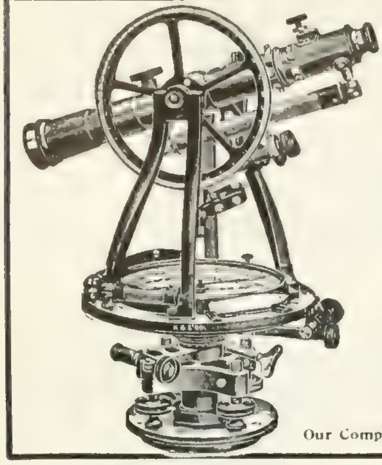
A Resurfaced Macadam Road after Oiling, at Delmar, N.Y.

WE MAKE A SPECIALTY OF

Heavy Oil of Asphaltum Base For Oiling Roads

Prompt shipments from Boston, New York, Philadelphia, New Orleans, Tampa, Fla., and Port Arthur, Texas.

General Offices: Frick Building Annex,
PITTSBURG, PENNSYLVANIA.



K & E SURVEYING INSTRUMENTS

TRANSITS, LEVELS, RODS, TAPES, ETC.

represent the latest progress in the art of making instruments of precision. They excel in design, workmanship, accuracy and durability. On account of their high quality our instruments are used on nearly every important work—Government, Municipal and Private.

When you are in the market for your Spring outfit write to us for quotations. We can supply every requisite of the engineer for the field or office.

KEUFFEL & ESSER CO.

127 Fulton Street, NEW YORK General Office and Factories, HOBOKEN, N. J.

CHICAGO, 111 E. Madison St. ST. LOUIS, 813 Locust St. SAN FRANCISCO, 48-50 Second St.

Drawing Materials, Mathematical and Surveying Instruments, Measuring Tapes.

Our Complete Catalogue on Request. Write for our 1908 Solar Ephemeris.

F. D. CROFOOT N. NIELSEN

Printing by Electric Light

Crofoot, Nielsen & Company

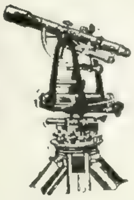
BLUE PRINTERS

Blue Printing, Black Printing **Blue Line and Color Printing**

Special Service Always—Speed and RESULTS. Big Floor Space and Equipment for Rush Orders.

167-169 E. Washington Street, CHICAGO

Phone 759 Main

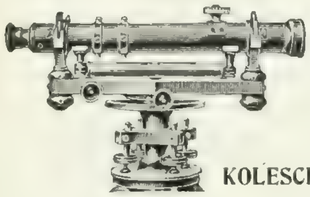


BUFF SURVEYING INSTRUMENTS

The "Buff" is constructed under the finest and most exacting supervision and checking.

Send for Catalog No. 3

BUFF & BUFF COMPANY, Boston, Mass.



IS IT LEVEL?

The use of an Architect's Level assures you of correct results and saves time.

Our catalogue describes this and other useful instruments.

KOLESCH & CO., 142 Fulton St., New York

R. SEELIG & SON

172 E. MADISON ST., CHICAGO

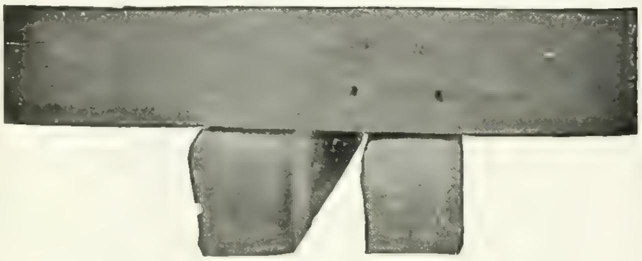
MANUFACTURERS OF MOST IMPROVED

ENGINEERING and SURVEYING INSTRUMENTS

SEND FOR CATALOG No. 6.

15 Mins. in Hot Paint Gives Life of 15 Yrs.

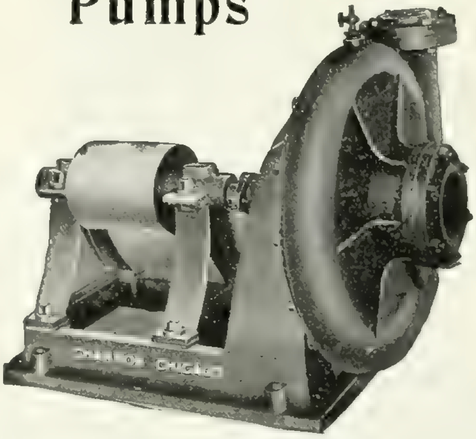
This photograph shows railroad ties of southern pine that were immersed 15 minutes in hot paint made by this company. After nine years service the ties are as sound as the day they were treated, which means that, at worst, they will have a life of not less than 15 years. The paint contains a germicide that is death not only to the fungus of rot but to teredos and all forms of timber parasites. No engineer who is concerned with the preservation of ties, piles, fences, telegraph and telephone poles, or bridge timbers, can offord not to send for our catalog at once and investigate this paint.



The Teredo-Proof Paint Company

17 Battery Place, New York

Channon Centrifugal Pumps



These pumps are well designed and heavily constructed throughout. The case or shell is of the solid type, very heavy, and the runner of large diameter, adapting the pump for slow speed.

Direct-Connected Outfits of All Kinds

Send for Catalog No. 33
Covering Contractors' Equipment.

**H. Channon Company.
Chicago.**

Ten Additional Letters Commending the American Society of Engineering Contractors.

Letters and applications keep coming to Mr Gillette, acting chairman of this new organization. The total number of applications now exceeds 900. It is the intention to effect a permanent organization when the number reaches 1,000, which, at the present rate of receiving applications, should be reached within a few weeks. Prominent contractors and engineers from all sections are applying for membership. A blank for the purpose can be found on page 35 of the advertising section.

Ten letters commending the formation of the society follow:

Sir: Enclosed herewith you will find my application for charter membership in the American Society of Engineering Contractors, which you are endeavoring to form. I have read with a great deal of interest your articles in the Engineering News and Engineering-Contracting regarding the attitude of engineers in general towards contractors and contracting, and your views on the matter meet with my hearty approval. The formation of a society of engineering contractors is a move in the right direction, and if the policy of the society is founded on broad and equitable lines it is sure to have a beneficial influence on future conditions. If there is anything I can do out here in the Pacific to help along the good cause I would consider it a favor if you would write me regarding the matter.

Yours very truly,
L. M. Whitehouse,
Engineer and Contractor,
Honolulu, H. T.

Sir: I am desirous of becoming a charter member of the American Society of Engineering Contractors, provided the dues and condition of membership shall prove satisfactory to me when they shall be decided upon.

Yours very truly,
A. H. Schilling.
Vice President and General Manager,
Steel and Hollow Block Building and Construction Co.,
Albany, N. Y.

Sir: Enclosed you will find my application as a charter member of the American Society of Engineering Contractors.

Yours very truly,
John L. Sheppard, Jr.,
Superintendent Construcion,
American Railway Co.,
Philadelphia, Pa.

Sir: I enclose herewith application for charter membership in the American Society of Engineering Contractors. I believe this society will be of great benefit to both engineers and contractors and if it brings about a uniformity and system in specifications, to say nothing of its other objects, it will have done a work every engineer and contractor will be thankful for.

Very truly yours,
A. F. Blair,
Blair & Van Gieson,
Tacoma, Wash.

Sir: I herewith enclose my application to become a charter member of the American Society of Engineering Contractors. Trusting that your efforts become successful, I remain,

Very truly yours,
Morris Bernstein,
Engineer for Reilly & Riddle,
Contractors.
Philadelphia, Pa.

Sir: I am desirous of becoming a charter member of the American Society of Engineering Contractors, provided the dues and conditions of membership shall prove satisfactory to me when they shall be decided upon.

Yours very truly,
Columbia Improvement Co.,
General Contractors.
Geo. C. Scales, Superintendent.
Columbus, Ga.

Sir: Only today I picked up a copy of Engineering-Contracting and read of the proposed formation of an American society of engineering contractors.

If I am not too late I should be pleased to be considered for membership in same.

Respectfully yours,
John L. Sanborn,
Engineer for J. C. Rodgers,
Contractor, New York.

Sir: I am desirous of becoming a member of the American Society of Engineering Contractors, provided the dues and conditions of membership shall prove satisfactory to me when they shall be decided upon.

Very truly yours,
Orrin Backus,
President Standard Construction Co.,
Portland, Ore.

Sir: I am desirous of becoming a charter member of the American Society of Engineering Contractors, provided the dues and conditions of membership shall prove satisfactory to me when they shall be decided upon.

Yours very truly,
D. E. Baxter, President,
D. E. Baxter & Co.,
Railroad Contractors,
New York.

Sir: I am desirous of becoming a charter member of the American Society of Engineering Contractors if provisions mentioned in your advertisement in Engineering-Contracting shall prove satisfactory. I am,

Yours truly,
E. B. Priest, Ch. Eng.,
The Lake Superior Southern Ry.,
Oshkosh, Wis.

LETTERS TO THE EDITORS.

Table for Relocation of Curved Boundaries.

Sirs: In "Engineering News" of March 12 some one signing himself "H. H. T." gave a table to be used in the relocation of curved boundaries for lots when all the stakes had disappeared, or in which only the radius and lot corners were given. The table gave deflections for chord lengths = R/100, R/50, R/33⅓, R/25 and R/20. The writer here presents a table including also R/10.

H. H. T. obtained the deflection angle by the formula $d = \frac{c/2}{R}$, in which c = chord length (ratio of R) and R = radius of curve. The table given was not absolutely correct for the reason that H. H. T. used a three or four place table and the deflection for R/100 he gave as being 0°17′ 07.25″. By using a seven place table the result is 0° 17′ 11.33″. In actual use, however, the difference is negligible in even a long curve. The ingenuity of the idea strikes the attention and it is to be regretted that H. H. T. preferred to hide his identity. To run out a curve it is simply necessary to set the instrument on one stake, A, sight to the other, B, plate clamped at zero, and measure chords and deflect from B towards A. He stated that for setting out curbs, sidewalks, etc., he found a chord length of R/25 gave the best results, while for grading R/10 was sufficiently accurate.

In "Engineering News" of April 24 is a letter from Mr. J. Calvin Locke, objecting to the table for the reason that the deflection for 18 stations (to take an example) of chord lengths, = R/100, is not exactly the deflection for 9 stations of chord lengths = R/50. He then proceeds to give a table that is mathematically accurate, I presume, but is not so valuable for the purpose intended as the table of the modest H. H. T. The reason is that the transit used by the average engineer generally reads to minutes, while only a few high priced transits read to 20 and 30 seconds. The differences in the deflections for the different radii are as shown in the following table computed by the writer:

R = 100c c = 1 d = 0° 17′ 11.33″ 30 stations, Δ/2 = 8° 35′ 39.90″
R = 50c c = 2 d = 0° 34′ 22.77″ 15 stations, Δ/2 = 8° 35′ 41.55″
R = 33 1-3c c = 3 d = 0° 51′ 34.20″ 10 stations, Δ/2 = 8° 35′ 42″.
R = 25c c = 4 d = 1° 08′ 45.73″ 7 stations, Δ/2 = 8° 01′ 20.11″
R = 20c c = 5 d = 1° 25′ 57.35″ 6 stations. Δ/2 = 8° 35′ 44.1″.
R = 10c c = 10 d = 2° 51′ 57.68″ 3 stations, Δ/2 = 8° 35′ 53.04″.

Taking, for example, the deflection for 30 stations with c = R/100, and using the same angle for 3 stations with c = R/10, the difference in angle amounts to a trifle over 13 ins., which even the most particular man will say is correct enough for all practical purposes. We cannot split hairs over deflections involving fractions of seconds when using a transit that is considered very high grade if it reads to 10 seconds. If we also consider c = 5 ft., R = 500 ft., the difference in location of the tack point will be so small that it is negligible.

In addition to the fact that H. H. T. gave the unit deflection for R = 100 c as being 0 17′ 07.25″ when it is really 0 17′ 11.33″, his table as printed contained a few errors which evidently occurred in the copying or proof reading, as the total additions seem to be correct, so the writer hopes you will publish the following table, which follows the arrangement of H. H. T., as the writer considers it the best form to use in the back of a field book:

DEFLECTION ANGLES FOR CURVES
When R = 100c, etc.

Deflection	100c	50c	33 1-3c	25c	20c	10c
0° 17′ 11.33″..	1	..	..	..	..	..
0° 34′ 22.66″..	2	1	.			
0° 51′ 33.99″..	3	..	1	..	..	..
1° 08′ 45.32″..	4	2		1	.	.
1° 25′ 56.65″..	5				1	..
1° 43′ 07.98″..	6	3	2		.	..
2° .00′ 19.31″..	7	...	..	..	..	..
2° 17′ 30.64″..	8	4	..	2	..	.
2° 34′ 41.97″..	9		3	..		..
2° 51′ 53.30″..	10	5		.	2	1
3° 09′ 04.63″..	11	..	..	..	..	..
3° 26′ 15.96″..	12	6	4	3	.	..
3° 43′ 27.29″..	13	..	..	..	..	..
4° 00′ 38.62″..	14	7	..	.	..	..
4° 17′ 49.95″..	15		5	.	3	..
4° 35′ 01.28″..	16	8	..	4		..
4° 52′ 12.61″..	17	..	..	..	..	..
5° 09′ 23.94″..	18	9	6	..	.	..
5° 26′ 35.27″..	19	..	..	..	..	..
5° 43′ 46.60″..	20	10		5	4	2
6° 00′ 57.93″..	21	..	7	..	..	..
6° 18′ 09.26″..	22	11	..	..	..	..
6° 35′ 20.59″..	23	..	.	.	..	..
6° 52′ 31.92″..	24	12	8	6		.
7° 09′ 43.35″..	25	..	..	..	5	..
7° 25′ 54.58″..	26	13	..	..	..	..
7° 44′ 05.91″..	27	..	9	..	..	..
8° 01′ 17.24″..	28	14	..	7	.	..
8° 18′ 28.57″..	29	..	..	..	..	..
8° 35′ 39.90″..	30	15	10	..	6	3

It may be said with respect to the above table that the engineer will seldom have as many as 30 stations to run out even with c = R/100. The value of c will seldom be less than 5 ft. and as lots are hardly ever more than 100 ft. wide and are generally less than 50 ft., it may be seen that the table is extended enough to be very useful. For other values of the ratio R/c the table of Mr. Locke may be used.

Yours truly,
ERNEST McCULLOUGH,

Chicago, Ill., April 24, 1908.

Bids were opened May 8 by the Public Service Commission of New York City for the construction of the first six sections of the 4th avenue subway in Brooklyn. The work was divided into six sections, the lowest bidders for each section being as follows: Sec. 1—Nassau to Willoughby St., James P. Graham, $1,020,476; Sec. 2—Willoughby St. to Ashland Pl., William Bradley, $3,436,019; Sec. 3—Ashland Pl. to Sackett St., William Bradley, $3,392,091; Sec. 4—Sackett to 10th St., E. E. Smith Contracting Co., $2,283,533; Sec. 5—10th to 27th St., James P. Graham, $1,413,635; Sec. 6—Remington & Sherman Co., and F. W. Carlin Construction Co., $2,799,000. The above bids are for the construction of the railroad work.

New York State will plant 1,100,000 trees in its Adirondack forest preserve. The State has purchased 950,000 seedling trees from Germany for this purpose.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0722. **Corrugated Metal Culverts.**—Crawfordsville Corrugated Culvert Co., Crawfordsville, Ind.

The culvert described in this 8-page pamphlet has circumferential corrugations and is made in sections which are bolted together. Price lists and tables of carrying capacity are given.

No. 0723. **Steel Office Furniture.**—The Berger Mfg. Co., Canton, O.

This catalog lists a great variety of steel filing cases and cabinets, office tables, chairs, desks and fittings. Clear illustrations are given of the various articles, with prices, dimensions, etc.

No. 0724. **Water Softeners.**—Buda Foundry & Mfg. Co., Chicago, Ill.

This is a well arranged 30-page pamphlet describing and illustrating the two systems (intermittent and continuous) of water softening handled by the company named. There are interesting discussions of fuel loss by scale in boilers, and economy of soft water. The pamphlet is of interest to motive power officials and power plant engineers.

No. 0725. **Filing Cabinets for Drafting Rooms.**—Hamilton Mfg. Co., Two Rivers, Wis.

This pamphlet illustrates and describes an excellent line of cabinets for filing tracings, blue prints, electrotypes, paper stock, etc., for drawing room use. The cabinets can be had in unit sections of ash or oak and of various dimensions commonly used for blue prints and drawings.

No. 0726. **The Hanna Riveter.**—Hanna Engineering Works, Chicago, Ill.

This is an unusually good example of descriptive catalog work. The distinctive characteristics of the Hanna riveter are described in comparison with other types of riveters and the construction of the riveter is described in detail. The pamphlet is worth securing.

No. 0727. **Concrete Machinery Handbook.**—Ransome Concrete Machinery Co., Dunellen, N. J.

A 200-page handbook of machinery manufactured by this company for making and handling concrete. It describes mixers of various kinds and for many purposes, barrows, boilers, hoisting engines, tools for surfacing concrete, Ransomite for making new concrete adhere to old and many other tools and products. There are nearly 100 pages of tables and other information that will be found useful to engineers, including methods of mixing concrete, cost data on the subject, and the layout of concrete mixing plant.

No. 0728. **Conveying and Other Machinery.**—The Link Chain Belt Co., 52 Dey St., New York.

A new general catalog of 208 pages just issued by this company. In this pamphlet the company's elevating, conveying and power transmitting machinery is well illustrated by photographic reproductions and drawings, and is also described, with sizes and dimensions and prices. Special attention is given to the Clouser High Speed Detachable Link Chain Belt, made by this company.

No. 0729. **Cement Concrete and Brick Paint.**—Wadsworth, Howland & Co., Inc., 156 Fifth Ave., New York.

A 40-page booklet telling how cement and concrete work can be decorated and protected by a paint that the manufacturers claim will not wear off. The appearance of the building or structure is very much improved, and the concrete is made damp proof. Buildings and other structures on which this paint has been used are illustrated.

Personals.

Mr. L. W. Anderson has been re-elected City Engineer of Grand Rapids, Mich.

Mr. Paul V. Hyland, Architect, has opened an office at 1601 Heyworth Bldg., Chicago, Ill.

Mr. Walter E. Truesdell, Civil and Mill Engineer, of New York City, has removed to new offices at 7 West 38th St., that city.

Mr. Ernest H. Du Vivier, Engineer, New York City, has removed his offices to the Hudson Terminal Bldg., 30 Church St., that city.

Mr. Walter Shepard, heretofore Chief Engineer of the Boston & Albany R. R., has been appointed Consulting Engineer, and Mr. Everett E. Stone succeeds him as Chief Engineer.

Cornwall, Plock & Saltzman, Consulting Engineers, have removed their offices from the Hartford Bldg., Broadway and 17th St., New York City, to the West Street Bldg., 140 Cedar St., that city.

Mr. T. Kennard Thomson, Consulting Engineer for bridges, railroads, foundations and buildings, has removed his offices from the Park Row Building, New York City, to the Hudson Terminal Building, that city.

Mr. George L. Wall, Chief Engineer of the Lima Locomotive Works, Lima, O., has been retained by the Committee on Per Diem of the American Railway Association to compile data upon which their report will be based.

Mr. Horace H. Lane, for the past six years in the employ of Westinghouse, Church, Kerr & Co., has opened offices at 822 Penobscot Bldg., Detroit, Mich., where he will engage in a general engineering and construction business.

Mr. H. J. Cox has resigned his position as Chief Draftsman with the Mississippi Central R. R. to accept an appointment as Assistant Chief Engineer of the Aberdeen & Tombigbee Valley R. R., with headquarters at Aberdeen, Miss.

Mr. H. L. Wells, formerly Advertising Writer for the Allis-Chalmers Co., Milwaukee, more recently Publicity Manager of The Power & Mining Machinery Co., Milwaukee, has opened an office in Chicago at No. 1205 Monadnock Block, for the general practice of technical or trade journal advertising.

Mr. Daniel E. McComb, for the past 21 years Superintendent of the Sewer Department of the District of Columbia, Washington, has resigned that position to become Chief Engineer of Sewers and Paving for the City of Havana, Cuba. Mr. McComb was in Cuba nine years ago, and helped to prepare the plans, under the direction of Gen. Lawton, for the $15,000,000 sewerage system in Havana.

Mr. Guy C. Emerson has accepted the position of Superintendent of Streets of Boston, Mass., in charge of the department recently formed by the consolidation of the Street, Sewer, Sanitary, Street Cleaning and Watering, Bridge and Lamp Departments. Mr. Emerson is a constructing engineer for the U. S. Reclamation Service; he has been granted a three years' furlough by the Government.

Everette St. John, for many years a prominent railway official, died April 21 at his home in Wellesley, Mass. Mr. St. John was born in 1844, and was first employed with the old Housatonic R. R. In 1863 he entered the employ of the Rock Island system, remaining with this road for over 31 years and eventually becoming its general manager. In 1895 he became vice president and general manager of the Seaboard Air Line, retiring from active business life in 1901.

The following assignments of officers of the Corps of Engineers have been made: Second Lieutenants Chas. L. Hall and Robert S. A. Dougherty upon the expiration of their graduating leave of absence will proceed to Fort Mason, Calif., for duty with Company A, First Battalion of Engineers. Second Lieutenants Virgil L. Peterson, John W. N. Schulz, Clarence L. Sturdevant and Earl J. Atkinson will proceed to Fort Leavenworth for duty with the Third Battalion of Engineers. Second Lieutenant Richard T. Coiner will proceed to the station of Company B, First Battalion of Engineers, for duty.

Dr. Jean Robt. Moechel, Chemical Engineer, and Burton Lowther, Civil Engineer, have formed an incorporation under the name of Moechel & Lowther Engineering Co., with office and laboratories at 1110-1112 Wyandotte St., Kansas City, Mo. This company will specialize in industrial engineering work and the utilization of by-products. Dr. Moechel has for many years been identified with the cement and clay industry of the middle West, the development of mineral and metal properties and sanitary work. Mr. Lowther, the junior member, has been in charge of general construction and development work in eastern and western states.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, Chicago
Telephone Harrison 6750

NEW YORK OFFICE: 13 21 Park Row
Telephone 5613 Cortlandt

BOSTON OFFICE: 170 Summer Street
Telephone 5082-4 Main

HALBERT P. GILLETTE . . . MANAGING EDITOR
DANIEL J. HAUER,
CHAS. S. HILL,
C. T. MURRAY,
F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . PRESIDENT
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.
Copy for regular advertising must be received not later than Friday preceding date of issue in which it is to appear. "Proposals," "Wants" and "For Sale" announcements can be inserted as late as Tuesday morning.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

The Importance of the Caption of an Advertisement and How to Prepare Attractive Captions..........303
How Can I Get Started in Contracting With Small Capital..........303

CONCRETE SECTION:

Safe Design and Construction of Reinforced Concrete Chimneys.......304

EARTH AND ROCK SECTION:

The Cost of Maintaining Horses in New York City..................309
A Machine for Digging Trenches or Canals..........................310
Drilling Blast Holes With a Rod Drill..........................310

GENERAL SECTION:

Letters to the Editors: Some Criticisms of Dredging by Contract and an Answer........................311
Data On Street Dust................313
Results of Tar and Oil Road Treatment Experiments Made at Jackson, Tenn., in 1905................314
PERSONALS 314

The Importance of the Caption of an Advertisement and How to Prepare Attractive Captions.

In preparing an advertisement it is the writer's practice to spend a long time considering what the caption shall be; for the wording of the caption, or title, determines largely the number who will read the text of the advertisement.

The commonest mistake made by advertisers is to use either the name of their product or their firm name as the principal feature of the caption. This mistake arises from a fundamental misconception of what a modern advertisement is. The first printed advertisement was undoubtedly evolved from the ordinary street sign, and consisted of the name of a product and the firm that sold it. In other words, the original advertisement was nothing more than a miniature street sign. The process of evolution, however, has made the modern advertisement a thing far different from the street sign in its form as well as in its purpose. But since evolution is not the work of a day or a year, we still have with us the progenitors of the modern ad. The dodo among ads is the big space filled with buxom black letters spelling the firm name and the product the firm sells.

"Who will read the fine print in my advertisement?" asks the advertiser who still clings to the sign-board style of advertising. Our answer is: Precious few, but the fault is not with the fine print so much as with the unattractive coarse print that dominates your ad in its caption. Your caption should be prepared with the sole object of creating an interest that will lead men to read the fine print which tells about your catalog or your product.

Your first step, therefore, should be to devise an attractive caption. To select one for example, there is the ad reading:

15 Mins. in Hot Paint
Gives Life of 15 Years.

Not a word is said about the name of the manufacturer in this caption. The object is to lead the reader to examine the fine print to ascertain how this result is attained.

Another caption reads:

Where Are the Wheels?

The object is to lead the reader to look at the illustration of a dump box that will fit any wagon gear, and to read the text about it.

Another ad reads:

Why the Oscillating Tower Eliminates The Dead Load.

A less intelligently worded caption might have read:

Cableways.

But it is altogether likely that comparatively few men would have read the fine print if the caption had been "Cableways," for, *unless a man is about to buy a cableway that caption will not attract his attention.*

Right here is the secret of successful advertising. Don't advertise merely to reach the man who is just *about* to buy. Advertise to make your product favorably and well known to the man who *may* buy some day. Not one advertiser in ten has appreciated this distinction, as may be quickly seen by running through the advertising pages of engineering and technical journals generally.

The writer's usual practice is to assign a large percentage of white space to surround the caption, and thus make it stand out boldly. Furthermore, it is his practice to use practically no display words in the body of the text, for large type, other than that in the caption at the top and the address at the bottom, distracts the reader's attention from the caption. You want the words of the caption to soak into his mind deep enough to import their meaning. Another reason against display words in the body of the ad is found in the tendency of a reader to read only the display lines and to skip the rest. Of course, when display words are so used as to arouse the reader's interest, without telling him the whole story, they can be used very effectively if the display is a modest one, and entirely subordinate to the caption.

Occasionally the entire absence of a caption and of display words will prove effective. The advertisements of the Macbeth lamp chimneys are a good illustration. But it would be a mistake for all advertisers to adopt this plan, since the reader would be apt not to notice many advertisements at all.

"How Can I Get Started in Contracting with Small Capital?

We have received a letter from a correspondent asking how he can get started in the contracting business. He states he has a capital of $5,000, and would like to go into the business of building houses.

There are several ways, as we have previously stated in these columns, for a man to begin contracting work. He may be able to secure certain real estate, and, by selling part of it, be in a position to build houses on the rest, thus combining construction work with property development.

Another method is to hit upon some meritorious idea in the building line, and, by the proper publicity, so associate this idea with his name that business will come to him. However, there are comparatively few who can get a start in this manner.

One method, open to any energetic man in a large city, is to start in a small way by taking sub contracts for some special work on a building. Today nearly every store building or warehouse, even if built of brick or lumber, has concrete footings and foundations. The outfit needed to put in such simple footings and foundations will not cost much. A concrete mixer, some charging barrows, a few concrete buggies and some small tools make up the list.

The contractor must get in touch with every builder and explain to him that he makes a specialty of putting in this class of work promptly and in a first class manner. The builder with his larger organization will not usually be in a position to do this work as quickly as the smaller contractor. The builder generally sublets the excavation, and by subletting the foundations, the sub contractor can be working on them before all the excavation is completed. This will allow the builder to move on to his job with a large force, well organized, and

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

erect the structure quickly on the completed foundation. Prices can be named on the work by the cubic yard, a lump sum for the job, or cost plus a fixed sum.

The first job obtained, a good foreman should be placed in charge; but the young contractor should give the job his personal attention, only being absent in looking up new work.

If he makes up his mind that he will do good work and have his job finished on time, and not avail himself of excuses that will give him extra time allowance, it will not be long before he has all the work he can do. As he gains experience and sees other classes of work done, he can enlarge his field. Where piles are needed under the concrete, he can drive them; he can do the excavation work and gradually increase his field until he will be able to take the entire contract for a building.

His experience will be valuable to him in many ways, and he may find it cheaper to sublet parts of his work to other contractors rather than to attempt to do all the work himself. In fact in the building line, although there are general contractors, yet much of the work is sub-contracted to men or firms who are specialists in their lines. One firm makes a specialty of foundations, another of concrete work, another of structural steel, another of cornices, others of the plumbing and so on indefinitely.

The excavation of basements is itself a special line of subcontracting that has proved profitable to those who are equipped with a good plant for the purpose.

There are firms in large cities that do nothing but furnish lime mortar for builders, hauling it in wagons from a central yard where the mortar is made. Portland cement, mortar and concrete could be handled in much the same manner, for a radius of more than a mile from the mixing plant.

We know of a firm that does nothing but shape and bend and fasten together steel rods for reinforcing buildings. It takes the drawings for a reinforced concrete structure, and delivers the reinforcement ready to be placed in the forms.

There is, indeed, no limit to the extent to which subcontracting may be carried, and subcontracting is usually the first step in entering the general contracting business.

Seconds Not Inches: A Correction.

Attention is called to a printer's error in our issue of May 13 which may cause some one confusion if not corrected. In his letter on "Table for Relocation of Curved Boundaries," Mr. Ernest McCullough is made to say that "the differences in angle amounts to a trifle over 13 ins." It should read 13 seconds instead of 13 ins. With this correction in mind the reader will have no difficulty in following the argument.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Safe Design and Construction of Reinforced Concrete Chimneys.

Reinforced concrete chimneys have met with varying degrees of success. In the majority of cases such chimneys seem to have served their purpose well and to promise quite as great success for this new material in chimney construction as in building work and other familiar types of structures. There have been, however, several rather disastrous reinforced concrete chimney failures and also a number of instances of cracking, disintegration and other partial failures that have reflected seriously on reinforced concrete. Believing that these failures must, in view of the well known success had with the majority of reinforced concrete chimneys, be the result of causes that could be removed, the Association of American Portland Cement Manufacturers engaged Mr. Sanford E. Thompson, M. Am. Soc. C. E., to investigate and report on the whole subject. Mr. Thompson's report has been widely published, but we believe that it contains information and suggestions that will be useful to our readers and we give it at some length in this issue:

The first reinforced concrete chimney was built in 1898 by the Ransome & Smith Company for the Pacific Coast Borax Company, Bayonne, N. J. Since that time about 400 stacks have been completed, and are distributed through nearly every state of the union and Canada. These stacks range in height above the ground from 50 to 352½ ft., with inside diameter ranging from 4 to 18 ft., the majority of them being 150 to 200 ft. high and 5 to 6 ft. in interior diameter.

Although the large majority of these chimneys have given satisfaction to their owners up to the present time, the failure of a few and serious cracks in several others have caused a number of inquiries to be made as to the reliability of reinforced concrete for chimney construction.

As a consequence of such questions your association has delegated the writer to investigate the causes of the faulty structures and the condition of the chimneys now in service, with a view to reporting whether reinforced concrete may be safely recommended for chimney construction.

With this in view the writer has visited and carefully examined a number of concrete chimneys, has investigated the causes for the defects in these structures, and has consulted with representatives of some of the companies which make a specialty of this type of construction. Through inquiries made by your association and by personal correspondence direct reports have been received upon 120 chimneys.

The results of this special investigation taken also in connection with two or three professional cases, in one of which opportunity was afforded for examination of the material in a chimney which was taken down, provide data for this report.

Conclusions.—It is thus possible to present quite definite conclusions and recommendations with reference to this class of construction. The general conclusions which follow will be considered in detail in subsequent portions of the report and reasons will be given for their adoption.

(1) Reinforced concrete is a suitable material for chimney construction.

(2) Reinforced chimneys must be designed and built upon the same principles and by the same methods which have proved essential in other types of reinforced concrete construction.

(3) The defects and failures which have occurred in chimneys thus far built have been due to poor workmanship, faulty design, or the use of wrong concrete mixtures, or to all three.

(4) The methods of construction at present being followed are, in many cases, defective and liable to lead to subsequent failures, and they should be radically modified.

Investigation of Chimneys.—As already intimated, several reinforced concrete chimneys have fallen while being constructed or at some later period, and the cracks developed in a number of others have raised serious question as to their safety. On the other hand, in general chimneys built of reinforced concrete have given perfect satisfaction, this being attested to by the fact that in many cases the owners have repeated their orders for such stacks, one corporation, for example, having built fourteen of them at its plants in various parts of the country.

The question then which confronts us is whether the faulty structures reported are due to qualities inherent in reinforced concrete or whether they are due to defects in design and methods of construction which may be amended in the future, or whether they may be considered simply as accidental failures to which all engineering structures are occasionally liable. In other words, shall we condemn the building of chimneys of reinforced concrete or may we disregard the comparatively few actual failures as accidental, or shall we approve of building concrete chimneys, at the same time insisting that to be sure of permanence, the methods of design and construction must be, in some cases, radically changed?

My investigation and examinations of chimneys have led me very decidedly to the third alternaitve. In other words, the writer is convinced that reinforced concrete chimneys can be built which are entirely safe and practically indestructible, while recognizing that many have been erected with an utter disregard of the fundamental principles which have proved essential in all other classes of reinforced concrete construction.

In the first place, as we consider the problem two principles must be recognized which may be termed axioms in engineering science. Namely, failures do not necessarily throw doubt upon any class of construction unless the causes for failure are incapable of remedy. On the other hand, the fact that a structure or many structures have not failed is no proof that they are properly designed and built, since they may not have met with the most severe conditions or may be already stressed to a point so near breaking as to be liable to future deterioration from heat and frost and continued vibration.

To review the subject, therefore, examination must be especially directed to the causes of the occasional failures and defects reported, with the object of determining if possible whether the conditions which have produced the troubles may be present in other chimneys and how they may be corrected in the future to prevent recurrence.

Eight cases have been reported in which chimneys have either blown over or have been taken down because they were defective, and ten or twelve others have been heard from in which cracks have developed which cause serious apprehension. In nearly every case of failure the chimney has been rebuilt by the construction company.

One of the failures most widely known is that which occurred at Peoria, Ill., in 1902. The chimney had been completed about three weeks when it gave way at the offset or projection, the upper part crumbling as it came down, and the concrete breaking into small chunks. The T-shaped steel stripped clean from the concrete. The cause is stated to be a poor batch of concrete at the offset, although the manner of failure would indicate that the concrete in the upper portion also was not of the best quality.

Another case is cited in which the chimney stood for nearly two years, and then blew over in a wind storm of about forty-five miles per hour. Here, as in the other case, the concrete stripped from the steel, and the fall was attributed to poor adhesion between the concrete and steel.

A stack built in very cold weather in Canada blew over when the concrete, which evidently froze without setting, thawed out.

A case occurred in 1905 in which the upper 30 ft. broke and slid off while it was being topped off, the accident being charged to the fact that the mortar had not properly set.

This year a chimney in the west, after about two years' service, developed such cracks that it was considered dangerous, and was taken down and replaced.

Another stack was torn down before the boilers were fired because of defects in the workmanship.

The most recent failure occurred this last summer in Wisconsin, where a chimney blew over, only two weeks after its completion, in a severe tornado which damaged many other structures. The blame is laid upon the unusual severity of the storm and the freshness of the concrete.

Considering the chimneys which are now in commission, we find that in general they are subject to more or less checking or cracking. This need not necessarily condemn the structure, since the reinforcement may be sufficient to safely hold together the blocks formed by the cracks, and yet it would seem with the opportunity we have of introducing steel wherever needed that all cracking ought to be averted, especially as there is always danger that the cracks may increase from wind vibration, heat and frost.

Our reports indicate in most cases that the cracks are not considered dangerous by the owners of the stacks. In several instances, however, long vertical cracks have appeared, and in others horizontal cracks have been found in the lower portion, which have given serious concern. One chimney, straight when built, has since leaned out about 3 to 4 ins. from the vertical, beginning at a point about two-thirds way from the base. Another informant reports soft spots.

Nearly 400 reinforced concrete chimneys have been built in this country, and direct reports have been received by your association and by the writer from nearly half of these. The failures cited amount to about 2 per cent of the total number, with at least 2 per cent to 3 per cent more of doubtful safety. It is probable that most of the seriously defective cases have been brought to light since special care has been expended in running down doubtful ones. Of the others and even where personal examination has revealed somewhat serious cracks, the general verdict of the users is "satisfactory" and "good."

Reinforced concrete chimneys offer special structural difficulty because of the heights to which they are carried, and the accompanying difficulty of obtaining the very best of workmanship. For this reason we might expect a somewhat higher percentage of error than in ordinary reinforced concrete construction. Taking this into consideration, however, even 4 per cent appears to be a somewhat alarming percentage of defective construction. But the vital question is whether even these few cases may be passed over as isolated cases of defective construction or whether they afford an arraignment of other chimneys now standing, and whether they predicate a similar percentage of defective construction in the future.

An examination by the writer of a chimney which was being taken down, if representative of others, throws considerable doubt upon their durability. On the other hand, it affords means for pointing out definitely the errors which must be guarded against in the future. This chimney showed soft spots in three sections, where the concrete could be readily loosened clear into the steel. The concrete was porous throughout, and scarcely bonded between the 6-in. layers. Samples cut from good portions of the concrete, which was one part cement to three parts sand, gave an ultimate strength of about 1,200 lbs. per sq. in. or about one-half the strength of a good 1:3 mortar laid with a sufficient quantity of water. A month after this inspection the chimney was taken down, the 6-in. layers being readily loosened from each other and cut in pieces by a pneumatic chisel, and the concrete was found to vary materially in hardness. Of special importance was the fact that the mortar in the angles of the T bars was weak and porous, showing scarcely any adhesion to the steel. Further investigation showed that the concrete of mortar used in the construction was of such *extremely dry consistency* that even where well rammed, the moisture did not cover all parts of the surface of a layer nor did it produce a proper bond with the steel.

From such evidence it is impossible to avoid the conclusion that other chimneys built by similar methods, with so dry a mixture as to give a weak, porous concrete and to provide insufficient adhesion to the steel, are likely to cause trouble in the future.

This appears to be a severe arraignment of concrete chimney construction. And yet, to be fair, it must not be overlooked for a moment that every one of the points brought out—the low strength of the concrete, the dry mix, the porosity, the lack of adhesion to steel, the lack of bond, and the soft spots—indicate construction which would not be tolerated in any other class of reinforced concrete work. It has been proved beyond a doubt, and reiterated in print and verbally, that reinforced concrete must be mixed *wet* in order to adhere to the steel and protect it from corrosion; that a factor of safety of four is certainly a minimum in compression; and that a concrete structure must be essentially monolithic. It should be clearly understood also that in the chimney to which I have just referred all of these essential elements were disregarded. The defects noted are not inherent in chimney construction. In other words, from a practical standpoint it is necessary to follow in chimney construction the methods which have been proved necessary for success in other structures made from reinforced concrete. As a proof of this we may simply point to the indisputable fact that concrete chimneys have been satisfactorily built with a proper factor of safety and with a wet mix which insures a positive bond to the steel, and with a dense concrete which protects the steel from corrosion and permits the bonding of the various parts of the structure.

Since reinforced concrete is everywhere being constructed on these principles, and is proving durable and satisfactory, and is being used under all conceivable conditions, we have ample cause for security in reinforced concrete chimneys provided they are properly designed and constructed.

Effect of Heat Upon the Chimney.—In the above discussion the effect upon the chimney of the interior heat from the boilers is not directly referred to. Just what part this has played in the faults which we have noted is uncertain. Undoubtedly the interior heat adds to the stress in the concrete, and thereby increases the tendency to crack, especially at points near the top of the inner lining. This simply indicates, however, that the quantity and arrangement of the steel reinforcement should be adapted to resist this extra stress.

When reinforced concrete was first introduced it was questioned whether with changes in temperature the concrete and the steel would not expand and contract unequally, so as to make them separate from each other. If this were the case, it would be especially detrimental to a structure like a chimney where the range in temperature is greater than usual. It has been proved conclusively, however, that concrete and steel have substantially the same coefficient of expansion; that is, with any degree of heat they expand and contract almost exactly alike. For this reason there can be no separation due to change in temperature.

The interior heat affects the shell in another way because concrete is a poor conductor. The interior surface for a depth of an inch or two is heated very much hotter than the exterior surface, and so tends to expand and crack the colder outside surface. This effect is most marked upon a thick wall, the action being similar to that of a thick glass bottle which breaks more readily when hot water is poured into it than does one of thin glass. The stress or pull on the outside surface must be met by increasing the amount of circular steel and placing it near to this outside surface.

The effect of heat upon the concrete material itself is also a point which must be considered in chimney design. In the earliest chimneys built the concrete lining extended the full height, while in later ones it has been generally carried up to only about one-third of the height. Usually the lining has been reinforced concrete, although in some cases firebrick has been used. A few chimneys have been built with no lining at all.

While much remains to be learned with reference to the effect of heat upon concrete, it is known to be a most excellent fire resisting material, although it has been found that a temperature as high as 1500° Fahr. continued for only two or three hours will draw out the water of crystallization so as to take out the strength for a depth of ½ to 1 in. Lower temperatures affect the material less, and tests at the Watertown Arsenal indicate that a good cement mortar will not be appreciably injured at 600° to 700° Fahr. Tests of actual chimney temperature are extremely meagre, but from records available we may say that the temperature in an ordinary chimney seldom exceeds 700° Fahr. at the base, while 400° to 500° is more usual. It is a fact not universally known among engineers that the temperature in a chimney remains quite high even in its upper portion. For example, in the test of one chimney the temperature at three-quarters of the height above the base ranged only 10 per cent to 20 per cent lower than at the flue. This makes it evident that if the lining extends only one-third of the way from the bottom, the design of the concrete shell above it should be adapted to resist considerable heat, while greater safety may be insured by extending the lining far above the lower third.

Your association has received no reports of injured linings. Many have never examined the interiors of their chimneys, several have reported that the lining was in good condition; one correspondent states that after three months' use the interior surface of the chimney is smooth, without cracks, and that the soot does not adhere to the surface but falls to the bottom or is carried out by the draft. Since the fire resisting quality of concrete increases very greatly with age, it is fair to assume that if the interior surface is sound at the end of the first two or three months it will not disintegrate after that time. Right in this connection Mr. E. L. Ransome reports on recent experiment of the inner shell of a chimney built nearly ten years ago of a true concrete of cement sand and crushed stone, in which he found the concrete in the hottest part of the chimney, opposite the flue, perfectly sound and exceptionally hard.

Concrete then may be considered as satisfactory for a lining of the inner shell in ordinary cases, although when exceptionally high temperatures are expected, say above 750° F., it is on the side of safety to employ firebrick.

Principles of Design.—Having taken up the causes which have made trouble in the past, it now remains to definitely outline the principles which must be followed in design and also to enumerate the details of construction which, in view of this past experience, are essential in reinforced concrete chimneys, which, if adopted, will warrant the adoption of this material as the standard for chimney construction. The limiting dimensions—that is, the interior diameter and height—must be governed by the boiler and other mechanical conditions. The dimensions of the walls and the amount of reinforcement must be accurately computed.

A brick chimney stands because of its weight, the outside diameter at the base being made so large that it cannot blow over. The stress which comes upon the brickwork is, therefore, essentially compression. A reinforced concrete chimney is of such small size at the base that it would topple over when the wind blew if it were not held by the steel. The wind pressure causes compression on one side of the chimney (the side opposite the wind) and tension or pull upon the side against which the wind is blowing. To take this pull, steel is imbedded in the concrete, and when the concrete is properly laid it bonds or adheres to the steel in such a way that they act together, just as they do in the bottom of a reinforced concrete floor.

In designing a chimney the thickness of the outside shell must be sufficient to bear, with the steel embedded in it, the pressure due to the weight of the chimney and to the wind. A proper number of vertical steel rods or bars must be inserted all around the chimney to resist the pull caused by wind pressure, and steel hoops must also be placed at intervals to stiffen the vertical steel and prevent cracks due to difference in temperature between the interior and exterior, and especially unless the concrete is found sufficient to resist the vertical shear which corresponds to the horizontal shear in a beam. It is customary to assume 50 pounds per square foot of vertical surface as a maximum wind pressure; this corresponds to the wind of 100 miles per hour. It can be proved mathematically that when wind blows against the curved surface, a part of it is ineffective, so that the total pressure against a vertical plane surface whose width is the diameter of the chimney is two-thirds the normal pressure. Hence 33 lbs. per sq. ft. may be taken for the pressure against a vertical plane. If the chimney is surrounded by buildings, this would, of course, act only above the roof.

The computation of stresses is by no means a simple calculation because of the combined action of the concrete and steel, which involves the elastic theories. A method given in the 1906 Handbook of the Expanded Metal & Corrugated Bar Co. and which we give in the appendix to this paper, although somewhat cumbersome for reviewing a chimney already built, offers as good a solution as has yet been given. In computing the stresses, allowance must be made for the weight of the chimney, and the vertical shearing stress must not be neglected.

As before stated, it is customary in chimney design to build an inner shell with an air space of 3 or 4 ins. between it and the outer shell. This inner shell is sometimes carried clear to the top of the chimney and in other cases about one-third the distance to the top, the object being to protect the exterior shell from the high heat of the boilers and provide an insulation which will prevent the lowering of the temperature of the gases which affect the draft.

Concrete chimneys frequently crack at and above the top of the inner shell, so that there is some doubt as to whether this should not be extended higher than the usual one-third. It ought to be possible, however, to so lay and reinforce the concrete as to prevent cracking even with the extremes of outside and inside heat, so that it does not seem advisable at this time to recommend a radical change in the height requirements. The inner shell must be entirely independent of the outer, as otherwise the expansion caused by the interior heat will tend to lift and crack the chimney at any point of contact. As already stated, reports from many users of concrete chimneys have shown interior shells of reinforced concrete to be in good condition, so that concrete inner shells should be satisfactory under ordinary conditions. It may be advisable for the present, however, to limit the use of a concrete lining to a temperature of 750° Fahr., since heat tests of concrete above this limit have not yet already established the effects of continued high temperature. This temperature is not often exceeded in the gases from an ordinary battery of boilers. If, for any reason,, excessively high temperatures are to be met, the lining should be of firebrick, and special studies be made to determine how high it should be carried.

If the inner shell does not extend to the top, the portion of the outer shell at the level where it stops should be especially reinforced by an additional amount of vertical and horizontal reinforcement, as the change in temperature is liable to start cracks at this point. Variation in thickness should be avoided if possible and if necessary should be provided for by additional reinforcement placed near the outer surface. Changes in section are bad because stresses are introduced which are indeterminate.

Since many chimneys have developed long vertical cracks, it follows that the horizontal or circular reinforcement should be increased. Closer spacing of the reinforcing rods is also advised so as to give more of a network which will bind the concrete and prevent the first formation of cracks. A spacing of 12 inches is certainly none too close in the lower half of the stack.

The foundation for the chimney must be designed according to recognized engineering principles. If piles are necessary, they must cover a sufficient area so that the line of resultant pressure will fall well within their area at the level where they run into hard ground. A neglect of this principle is the probable cause of settlement of at least one chimney. The thickness and reinforcement of the concrete in the footing are matters of mathematical computation from the stresses caused by the weight and the wind pressure. In general, we may say that the area must be sufficient to prevent overturning. The allowable pressure on the soil must not be exceeded, the thickness of the concrete reinforcement must be sufficient to resist punching shear, horizontal shear, tension and compression.

Unit Stresses.—As stated above, it is good practice to compute a chimney for 50 pounds per square foot of wind pressure. This represents maximum velocity, and as there is no danger of exceeding it, at first thought it might seem permissible to employ a smaller factor of safety than is common in other constructions. That is, it would seem that the safe stresses might be taken nearer to the maximum computed stress. However, while it is true that the velocity of 100 miles per hour will never be exceeded, it is for several reasons unsafe to take any greater risk in chimney construction than in other engineering structures.

(1) If a chimney does fall, it endangers life and property.

(2) Its height above ground makes inspection of the workmanship more difficult and the attainment of perfect homogeneity less easy.

(3) The wind causes vibrations which produce repetition of stresses.

The last reason is of such importance that the discussion of the other two may be neglected. Repeated blows or repeated compressions and pulls upon any material tend to weaken it. Many tests and experiments show that reinforced concrete is admirably adapted to sustain shocks and repeated loadings (much better, for example, than brick work), yet nevertheless these same tests also show that when such conditions of repeated stresses occur, reinforced concrete, like any other material—even iron and steel—will fail at a lower stress than it otherwise would, and therefore must have a large factor of safety.

The writer would suggest the following unit values as safe for reinforced concrete chimney construction:

Extreme Fiber Stress in Compression.—Concrete, provided it is capable of attaining a strength of 2,500 pounds per square inch in 28 days, 600 lbs. per sq. in.; steel in tension, 14,000 lbs. per sq. in.; concrete in shear, 60 lbs. per sq. in.

Materials.—In so important a construction as a chimney it is necessary that all the materials entering into it shall be of very best quality.

Cement. The cement should be such as will satisfy the standard requirements of the American Society for Testing Materials, and the cement actually entering into the chimney should be carefully sampled and tested.

Sand. Sand is not usually tested in concrete work, but it should be tested in the case of any important structure. In a number of concrete failures, not failures of chimneys, which have recently come to the personal knowledge of the writer, the inferior quality of the sand has seriously contributed to the failure. If the sand appears clean and its mechanical analysis or sieve test shows that not more than 30 per cent will pass through a sieve having 40 meshes per linear inch, and if a sand from the same bank has been used in other concrete work which has hardened satisfactorily, it may be accepted without further test, although even then it is advisable to have samples made up in the proportions and with the cement to be used, and tested in a laboratory. If the sand is dirty, or is finer than this—that is, if more than 30 per cent passes a sieve with 40 meshes per inch—a representative sample should be sent to a laboratory and thoroughly tested and either a coarser sand substituted or richer cement proportions than usual adopted. If the sand comes from a bank which has never been used for concrete, it should be submitted to laboratory test notwithstanding its apparent good quality, since it is absolutely impossible to accurately pass upon any sand sample by merely looking at it.

Stone. It has been customary in the past to use a sand mortar for chimneys instead of a true concrete. There is no reason, however, why a clean sand gravel or a fine hard crushed stone—such as trap—cannot be used with the sand for the outer shell with a reduction in cost, and an increase in density which will make the concrete stronger and less porous. Instead, for example, of using a mortar, one part cement to three parts sand, a concrete of one part cement, two parts sand and two parts ½-inch stone or gravel will undoubtedly be stronger, denser and more water tight. Several chimneys have already been built using broken stone as a part of the aggregate. Coarse stone to ¾ inch or 1 inch could be introduced and still have a strong mixture, but as this is less fire resisting than a finer material it is not advisable.

Tests would probably indicate that the true concrete is suitable for the inner shell as well as the outer, but until this is proved, it is perhaps advisable to continue the use of a mortar for the inner shell.

Water. Water used in mixing is customarily required in specifications to be free from acids, alkalies, and vegetable matter. In chimney construction it is equally imperative that the proportion of it shall be gauged exactly right; *i. e.*, more of it used than has been customary so as to produce a dense mixture with perfect adhesion to the steel.

Steel. Round and shaped steel bars, such as twisted or corrugated or T-shaped, have been used in chimney construction. Steel with deformed surface gives greater adhesion than the round, but as the round is quite generally adopted in other reinforced concrete construction, it seems quite safe to use it for chimney construction. With T-shaped steel a perfect bond with the concrete is more difficult because it is hard to get the tamping into the angles.

Ordinary market steel whose breaking strength in tension is about 60,000 pounds per square inch may be safely used. High carbon steel would give a greater factor of safety, but unless of very high quality—which is difficult to attain without such severe specifications that the cost becomes too large for small structures—high carbon steel is apt to be more brittle and therefore of no advantage. Even with the very best high carbon steel, it is not advisable to allow a pull much greater than 14,000 pounds per square inch, because when this is exceeded there is a possibility of cracks forming in the concrete. It is, of course, impracticable to make the steel rods[4] long enough to reach the entire height of the chimney. They have therefore to be lapped and this lap should be a distance corresponding at least to fifty times the diameter.

The principles of reinforced concrete construction which have proved essential in other classes of work and as outlined in the book of Taylor & Thompson, for instance, must be followed for chimneys. A disregard of these principles is bound to cause trouble.

First and most essential is the proper proportioning and mixing of the concrete. The measurement of the sand for every bag of cement must be made in exact measure, and the mixing must be thorough—at least three turnings dry and three wet being required. Special care must be taken in gauging the water. The amount of water to use cannot be expressed in a percentage because different kinds of sand and different brands of cement require different proportions, and furthermore the amount to use to produce the same consistency in the concrete will vary from hour to hour.

It is absolutely wrong, however, to lay any concrete, in which steel is imbedded to take the pull, with what is termed a "very dry" mixture. This dry consistency has been frequently used in chimney construction in the past, and appears to be the principal cause of the actual failures and to contribute to a large number of the cracks which have developed in many of the chimneys now standing.

The consistency with which concrete is placed must be wet enough to quake—that is, to form a jelly-like mass; not necessarily wet enough to flow, but with sufficient water so as to insure that in every batch of concrete light tamping will bring the water to the surface. When a very dry mix is used, the water may come to the surface next to the forms, and thus give a good looking concrete, but it will be dry in the center and around the steel where it is most needed. Furthermore, by mixing just on the danger limit, occasional batches will be even dryer than the average, so as to permit soft, porous places in the concrete.

These statements are not theoretical, but are the result of actual and extended observation of the results coming from this practice.

With a wet mix, the forms cannot be raised quite so easily as with a dry mix, and the surface will not be of so uniform a color, but nevertheless a wet mix is necessary to produce a dense water-tight concrete and to make it adhere to the steel.

It has been found possible under ordinary weather conditions with a quaking mixture to raise the forms or molds the day after the concrete is placed, but to be on the safe side, two sets of forms may be employed, and raised alternately.

Another objection to dry mixed concrete is the lack of bond between the different layers. Although the stress on the concrete is chiefly compression so that joints in themselves may not cause failure, they permit cracks to open when the pull comes upon the steel and the water may penetrate to the steel with danger of its rusting. Each batch of concrete should therefore be incorporated with the one below it, and on beginning a day's work the surface should be thoroughly cleaned and soaked with water, and then a layer of neat cement spread upon it to form a bond between the old and the fresh concrete.

It is essential in the construction that the forms be held absolutely rigid while the concrete is being placed and until after it has set. A slight disturbance may form a crack in the interior of the concrete next to the steel so as to scale off later. The steel must be carefully placed, the vertical steel being preferably about in the center of the wall and the horizontal steel outside of it. In places where special temperature stresses occur, the horizontal steel should be as near as practicable to the outside surface, although not nearer than 1½ inches. The steel must be well bonded, and the concrete carefully placed and tamped around it, being sure that the concrete next to the steel is actually wet and quaking.

The outside surface must be formed by the molds, no interior plastering being permissible, as this is almost sure to check and scale off with the action of the weather.

The concrete must be laid before the initial set of the cement because regauging retards the set.

Summary of Essentials in Design and Construction.—In closing a recapitulation of the most essential requirements for reinforced concrete chimney design and construction may be made:

(1) Design the foundations according to the best engineering practice.

(2) Compute the dimensions and reinforcement in the chimney with conservative units of stress, providing a factor of safety in the concrete of not less than 4 or 5.

(3) Provide enough vertical steel to take all of the pull without exceeding 14,000 or at most 16,000 pounds per square inch.

(4) Provide enough horizontal or circular steel to take the vertical shear and to resist the tendency to expansion due to the interior heat.

(5) Distribute the horizontal steel by numerous small rods in preference to larger rods spaced farther apart.

(6) Specially reinforced sections where the thickness in the wall of the chimney is changed or which are liable to marked changes of temperature.

(7) Select first-class materials and thoroughly test them before and during the progress of the work.

(8) Mix the concrete thoroughly and provide enough water to produce a quaking concrete.

(9) Bond the layers of concrete together.

(10) Accurately place the steel.

(11) Place the concrete around the steel carefully, ramming it so thoroughly that it will slush against the steel and adhere at every point.

(12) Keep the forms rigid.

The fulfillment of these requirements will increase the cost of the structure, but if the recommendations are followed, there should be no difficulty in erecting concrete chimneys which will give thorough satisfaction and last forever.

A reinforced concrete pneumatic caisson was used to facilitate the construction of a connection at Jersey City between the Hudson Company's tunnels under the North River and the divergent branch tunnels to the terminals of the D. L. & W. R. R. and the Erie R. R. The caisson was sunk at 15th St., Jersey City, near the working shaft for the main tunnels. The single track tunnels of the connections were located to clear each other vertically and as the tunnel structure at this point could not be readily built by ordinary tunneling methods, special provision was made for the use of a caisson sunk 80 ft. through earth and water to rock. The caisson was pentagonal in shape, and about 50 ft. wide by 100 ft. long. The caisson was built in forms on the surface of the ground where the interior chambers were completed. These interior chambers consisted of a working chamber and separate upper chamber. The working chamber eventually formed a section of the low level tunnel, while the upper chamber formed the corresponding section of the upper level tunnel. The working chamber was provided with an air tight lining cemented in position to prevent the leakage of air pressure through the concrete.

The first turbines to be installed on a Japanese ship have been shipped from the Fore River Shipyards for the new Japanese cruiser Ibuki. The turbines will develop an aggregate of 27,000 H. P., and the cruiser is designed for 23 knots speed, with 14,500 tons displacement.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Cost of Maintaining Horses in New York City.

In the report of the Commission of Street Cleaning and Waste Disposal for the city of New York, previously referred to in our columns, the commissioners, Messrs. H. DeB. Parsons, Rudolph Hering and Samuel Whinery, give the cost of maintaining horses used by the city in street cleaning and waste disposal. We extract the following from their report.

The city owns its horses, and, as a rule, they are of good quality for the purpose and in excellent condition. In the boroughs of Queen and Richmond additional horses are hired.

TABLE NO. 1.

(Rental of Stable, 1906.)

Borough	No. Stables.	Av. No. Horses Kept in Rented Stables.	Rental per Horse per Year.	Month.	Day, 365 Days per Year.
Manhattan and Bronx	12	999	$41.44	$3.46	$0.113
Brooklyn ..	9	622	19.94	1.66	0.055

The cost of maintaining the horses, as shown by the department, appears to be higher than it should be. The stables are used for the storage of carts and other apparatus, as well as for the stabling of horses, and the rental, therefore, should be divided. Assuming that two-thirds of the rental is chargeable to the keeping of the horse, the rental cost per horse is as given in Table No. 1.

TABLE NO. 2.

Cost of Keeping Horses, Year 1906.

Borough	No. of Horses.	Yearly Labor at Stables, per Horse.	Yearly Feeding and Bedding, per Horse.	Yearly Shoeing, per Horse.	Veterinary, Medicines, etc., per Horse.
Manhattan and The Bronx	1,175	$237	$171	$18.30	$5.63
Brooklyn ...	681	268	171	17.75	9.08
Richmond .	79	194	149	21.07	8.20
Total and average .	1,925	$246	$170	$18.28	$6.94

The other items of the cost of keeping the horses for the year 1906, except that of repairs to stables, which is small, are given in Table No. 2. The labor cost is clearly excessive. In arriving at the totals for this item, we have assumed that only one-half of the salaries of the stable foreman is chargeable to the keeping of the horses. It will be seen that the cost of labor per horse per year amounts to $237 in Manhattan and The Bronx, $268 in Brooklyn and $194 in Richmond, the average for all being $246. These figures amount per horse per day to 65 cts., 73½ cts. and 53 cts., respectively, for the boroughs, with an average for all of 67½ cts.

The yearly wages paid to stable men were:

Stable foremen	$1,300
Assistant stable foremen	1,000
Acting assistants to foremen	900
Hostlers	720
Stable men	720

Hostlers are paid $2.30 extra for Sunday.

The quantity and value of forage actually consumed during the year in the boroughs of Manhattan, The Bronx and Brooklyn was:

	Quantity.	Value.
Oats, lbs	14,224,168	$200,300.46
Hay, lbs	9,991,330	90,413.13
Straw, lbs	1,893,633	14,330.79
Bran, lbs	775,396	7,909.81
Oil meal, lbs	72,876	1,207.48
Oat meal, lbs	12,165	365.73
Coarse salt, lbs	28,332	158.05
Rock salt, lbs	93,935	699.68
Ground oats, lbs	57,004	768.54
Ground corn, lbs	28,419	357.96
Ear corn, lbs	800	16.00
		$316,527.63

The cost of caring for the sick horses in the same three boroughs was:

Six veterinaries	$9,000
Veterinary supplies	2,886.60
Druggist	900.00

The cost of shoeing per month in Manhattan and The Bronx was: draft horses $1.49 and driving horses $1.40. In Brooklyn draught horses cost $1.35 per month to shoe, while driving horses cost $1.30 per month. This work was done by contract.

Each day in these three boroughs 57 loads of stable manure was hauled away, the average weight of a load being 1,500 lbs.

Table No. 3 shows the total cost of maintaining the horses, divided into costs per horse per year, per month and per day.

These figures do not include coal for fires in the stables, repairs and sundries.

These figures require no comment. Every one who has had experience in the keeping of horses will agree that the cost is too high.

We have obtained from a number of private corporations engaged in the transportation business in New York (some of them owning and working hundreds of horses that are employed for longer hours and in harder work than is required by horses of the city) statements in detail of the cost of keeping their horses. The average cost, including rental, or a liberal allowance therefor, appears to be about 90 cts. per day, equal to about $330 per year.

At all the stables in the city there were employed in June, 1907, 201 hostlers and 209 stablemen, besides the 81 stable foremen, assistant stable foremen and acting assistant foremen. The number of horses kept was 2,064. Therefore, 410 men were employed as hostlers and stablemen to care for 2,064 horses, or one man was employed for every five horses. Our information, supplemented by opinions of those who have had experience in taking care of horses, is to the effect that one man should care for from eight to ten horses. Taking the lower of the figures, the force of hostlers and stablemen at the department stables could be cut down from 410 to something like 258. We are also of the opinion that the number of assistant and acting assistant foremen could be reduced.

TABLE NO. 3.

Total Cost of Keeping Horses, 1906. Average Cost of Keeping One Horse One Year, 365 Days.

Items.	Manahattan and The Bronx	Brooklyn.
Average number horses kept	1,174	681
Cost of stable rental, Table No. 1	$ 41.44	$ 19.94
Cost of labor at stables, Table No. 2	237.00	268.00
Cost of feed and bedding, Table No. 2	171.00	171.00
Cost of shoeing, Table No. 2	18.36	17.75
Cost of veterinary attention, Table No. 2	5.63	9.08
Total	$473.43	$485.77
Equal to per month	$ 39.45	$ 40.48
Equal to per day, 365 days per year	1.30	1.33
Equal to per day, 310 days per year	1.53	1.57

The U. S. Senate has ratified the Canadian international boundary treaty. It provides for a more complete definition and demarcation of the boundary between the United States and Canada, but does not change in any way the understood existing line.

Lumber, classed as "boards, planks, and deals," cost on an average $20.28 per M feet in March, 1908, against $18.56 in the corresponding month of last year.

A Machine for Digging Trenches or Canals, or for Scalping Large Areas and Loading Into Wagons.

The machine illustrated in Figs. 1 and 2 is unique among the so-called "ditching machines" in that it can cut and widen a ditch by taking off successive slices. This enables the machine to be used for digging trenches, or for digging wide canals, or, indeed, for stripping areas of earth to any extent and to any depth.

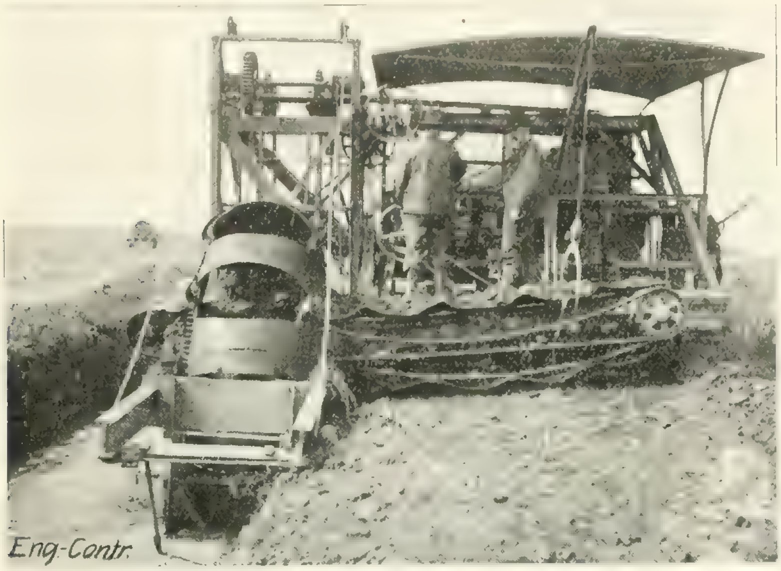


Fig. 1—View Showing Machine Widening Ditch in Soft Peat Soil.

Fig. 1. shows the machine widening a ditch in soft peaty soil, so soft that the soil flows. Note particularly that the excavating wheel is located at the rear of the machine and to one side. The machine can travel up one side of a canal that it is digging and down the other side, taking off slices. The number of slices that can be taken off depends solely upon the length of the belt conveyor.

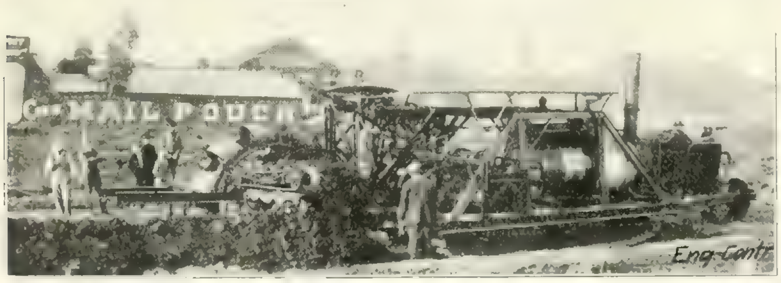


Fig. 2—Side View of Machine Working in Hard Ground.

Fig. 2 shows the same machine digging in hard ground. When working in tough material the machine made a cut 3 ft. wide and 6 ft. deep at the rate of 10 lin. ft. per min. This is at a rate of more than a mile a day.

The machine is provided with the Holt "platform wheels," which have been so successfully used for years on the Holt traction engines. Where traction engines have to operate over soft ground these "platform wheels" are indispensable. On this particular machine each "platform wheel" is 17 ft. long from center to center of the two sprocket wheels that carry the "platform." The "platform" is essentially an endless railway track, the rails being made up of short sections linked together, to which are fastened planks 2½ to 3 ft. long. With these "platform wheels" the machine is able to walk right across an open ditch 6 ft. wide. This gives an idea of the excellent bridging quality of the "platform" wheel."

All the motions of the machine are controlled by one man. By operating a lever he can raise either end of the cutting wheel, or both ends. The machine has several different traveling speeds, a very low speed for tough material and heavy digging, and higher speeds when the work is easier. All speeds are under the instant control of the operator.

It is clear that this machine ought to have a wide field of usefulness not only for digging trenches in streets, and for drainage ditches, but for general excavation work. The machine can be used to load wagons, very much as an elevating grader is used.

The inventor of this excavator is Mr. C. J. Van Buren, and the machine is manufactured by the Stockton Ditcher Co., Stockton, California.

Drilling Blast Holes With a Rod Drill.

In drilling holes for blasting at Ellensburg, Washington, on the new line being built by the Chicago, Milwaukee and St. Paul R. R., a 3-in. Cyclone rod drill (or well drill) is used by the contractors, Lorimer & Gallagher. The material is hard basaltic rock, full of seams and crevices, making difficult drilling.

A careful record of the work of the machine was kept for the month of March The machine, operated by 2 men, a driller and a helper, drilled 1353 lin. ft. of hole. The total number of hours worked was 259. This gives a record of 52 ft. per 10 hr. day.

This time includes moving the machine from one hole to another, and all delays during working hours incidental to work of this character. The average depth of the holes was 23 ft., so to do this amount of work 2 set ups were made on an average a day, there being 59 holes drilled and work was done on 27 different days. This is a very creditable record of drilling blast holes and is far cheaper than could be done by hand.

In 1907 a section of Chestnut street at Easton, Pa., was surfaced with Tarvia to prevent the "raveling" of the surface stones. The section treated was 1,183 ft. in length and had an area of 3,650 sq. yds. The street had a grade of about 9 ft. per 100 and is constantly baked by the sun. The detailed cost of the work according to the annual report of Mr. John McNeal, City Engineer, was as follows:

	Total	Per sq. yd.
Tarvia, 1,100 gals., at 7½ cts.	$ 82.50	$0.023
Freight and teaming of Tarvia	32.00	.008
Sweeping street for Tarvia	34.50	.009
Heating and spreading Tarvia	36.20	.010
Trap rock screenings, 59.8 tons at $1.58	94.48	.026
Spreading screenings	7.00	.002
Rolling	2.22	.001
Total	$288.90	$0.079

For each square yard of surface covered 3 gallons of Tarvia was used. Common labor was paid 20 cts. per hour and team and driver 50 cts. per hour. The report states that the results obtained were satisfactory as the street was in good condition throughout the season.

The output of coal in 1907 in the United Kingdom was nearly 268 million tons, an increase of over 16½ million tons as compared with 1906. The total number of persons employed at mines under the coal mines regulation act and the metalliferous mines regulation act in 1907 was 940,618.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

LETTERS TO THE EDITORS.

Some Criticisms of Dredging by Contract and an Answer.

Sirs:

I have read with considerable interest the article by Mr. Wm. P. Ryan in your issue of April 1 concerning the government ownership of dredges.

It is, of course, perfectly natural that any man should argue in favor of his own pocketbook, a fact which Mr. Ryan candidly admits. He has at heart the interests of the dredging contractors and not those of the government nor the people, and as a consequence his arguments are largely ex parte in their character.

This argument about monopoly has two sides. The government has no desire to make unto itself a monopoly of any field of endeavor to the injury or ruin of honest private contractors. Nor, on the other hand, does the government intend to allow itself to be made the victim of a monopoly. We have only to examine the cases on record to find out the origin of the monopolies that have been most injurious to the people. They are not public but private.

Mr. Ryan states that the competitive system has been the vitalizing principle of our public life. Quite true; and, on the other hand, illegal private monopolies have within late years been the de-vitalizing principle of our national life, oppressing our people and crushing out honest and unhampered competition.

But these remarks about individual liberty, socialism, etc., are not altogether germane to the subject. It is a business proposition, and must be argued as such.

The government has an inalienable right to do its own work in the most economical manner with the least expenditure of the people's funds. It has just as much right to own and operate dredges as it has to own and operate a government printing office or a government armory.

Construction by contract has, in most instances, been deemed the most practicable method of carrying on the government works. This has been the usual method. But the government reserves to itself the right to use day labor whenever the interests of economy demand it, and the many occasions on which public works have been constructed by day labor at a cost less than the lowest bid received are a sufficient justification, while by no means proving that the contract system is not, generally speaking, the best.

The right to resort to day labor in certain cases is the government's only protection against the greed and unscrupulousness of dishonest contractors, for unfortunately there are such members in a profession generally of high standing. If the government had no dredges, monopoly amongst the dredging contractors would be invited, and would occur in many instances. Monopoly in restraint of competition is the spirit of American business life, deny it who will.

When a very young engineer, the writer visited a harbor on the great lakes and there found lying up in desuetude (not innocuous) a government dredge. On inquiry he found she was out of commission and had been for some time. He was informed that the dredging was being done by contract. "Then why do you not sell that dredge or transfer her to another district, instead of allowing her to lie idle?" was asked. "Sell her!" replied the engineer in charge. "Never! That dredge pays for herself while lying idle in keeping down the bids. If the contractors did not know that we had her, their prices would be sky high and we would have no protection." And there you get an insight into the government's position.

On account of the expensive special plant required in dredging operations the government is more likely to suffer from excessively high contract prices because of the difficulty of resorting to the protection of day labor. If the U. S. has no right to own a dredge what right has it to own a hoisting engine?

As to the specific cases cited by Mr. Ryan, these do not disprove the occasional nor even the frequent necessity of resorting to day labor. The writer was for a time in charge of the dredging in Sabine Pass, one of the instances cited. The contract price at that time was very low, so low, in fact, that the representative of the sub-contractor for the work claimed that his company was losing money. A careful record of the cost of operations made by the government representatives indicated that the price paid more than covered the cost. Nevertheless the contractor was losing money on the job for the reason that if his dredge could have been released it could have been more profitably employed elsewhere. The cost of the government dredging done at the same locality could not fairly be compared with that of the contractor, for the reason that it was done under very different conditions, the contractor working in quiet water pumped ashore through a pipe line, whereas the government dredge worked here and there as needed, often in a seaway, with a hopper dredge, often dumping miles from the place of work. Yet there was very little difference in the cost. The maintenance of a channel with work here and there, for year after year, would naturally be more expensive than a single definite job pushed steadily to a finish.

Mr. Ryan states in one place that individual liberty explains "our industrial and commercial supremacy. While this has no bearing on the discussion, I yet beg to differ with Mr. Ryan and to assert that the great material resources of our country account for our supremacy. The sooner the American people realize that it is the country and not themselves that is great the sooner they will endeavor to be worthy inhabitants of the great country God has given them.

It implies no reflection on the integrity of the contracting profession at large to state that cases of monopoly and dishonesty have been sufficiently numerous to warrant the government in taking steps to protect itself against such monopoly. The case of the Bridge Trust, so called, in Ohio a few years ago, is one which came immediately under the writer's notice. The dredging trust, protected by a prohibition against the use of dredges by the government, would be quite as likely as any other trust to resort to monopoly from which the government, being its principal customer, would be the greatest sufferer. The "Life and Troubles of Mr. Bowers" form an interesting chapter in the history of the dredge trust, and this gentleman would probably not bear out Mr. Ryan's statements as to the "liberality" of the dredging interests.

Mr. Ryan further asks, "With what hope of success can we engage in the unequal contest of competing with the greatest government on earth?" If the dredging contractors will do the government work at a less cost than the government can itself do this work, as Mr. Ryan says they can, and if they will refrain from boosting prices when they think they have the opportunity to do so, that is their hope, and their only hope, of successful competition.

In opposing government monopoly Mr. Ryan should concede to the government the equal right to protect itself against monopoly, which in this instance it has good cause to fear.

Very truly yours,
P. S. Bond,
Captain, Corps of Engineers, U. S. Army.
Fort Leavenworth, Kansas.
April 8, 1908.

Sirs:

The broad gauge principles enunciated by Mr. William P. Ryan in his protest against government ownership of dredges, published in your issue of April 1, are interesting, but do not cover the whole subject.

Government dredging can be divided into two classes, ocean bar dredging and harbor dredging. The first of these can only be performed by special dredges built for the purpose. The government is the only patron of such dredging. No private concerns have any ocean bars to dredge. The dredges built for it are not well adapted to any other kind of work.

If this ocean bar dredging is done by private dredges, and there are only enough of them to do the work, there can be no competition, and the government would be at the mercy of the dredge owners.

If, on the other hand, there were enough of such dredges to give competition, those which do not get the work would have to lie idle, and, in the long run, the government would have to pay the expenses of all the dredges, including the idle ones, plus a profit.

The only practicable solution in this case is for the government to own its own sea going dredges.

The second class of work, the harbor dredging, is different. The government is only one of many patrons for this kind of work, and if thrown open to fair competition, the work could be done economically and there would be no need of the government's going into this kind of dredging business. That it has done so the dredge owners have only themselves to blame.

Such dredges are heavy, clumsy affairs, are not self moving, and towing them long distances is an expensive and difficult operation.

The result of this is that the dredging on the Atlantic coast is done entirely by Atlantic coast dredges; there is another set for the lakes, a third for the gulf, and a fourth for the Pacific coast.

Dredges are also expensive to build, and they deteriorate if they are kept idle.

The natural consequence is that each of the four groups is united into an association. Some years ago I was given an official copy of the minutes of one of the meetings of the Atlantic Coast Dredging Association, in which certain of the members protested against the association's continuing its policy of allotting work at different points to different dredge owners.

I do not know that the protest carried. It would have been very remarkable if it did, because that arrangement gave the association the work at its own prices and made government competition a farce.

Shortly after that I let a contract for dredging and required each bid to be accompanied by an affidavit stating that the owners of the dredges that the bidder proposed to use were not interested by pooling arrangement or otherwise with any other contract or dredging concern. I got practically no bids.

If the dredge owners instead of banding themselves together had permitted the action of the high grade principles used by Mr. Ryan in argument to be actually applied to the work, they would not now be in the position of probably losing all government contracts, because it has been discovered that a competent dredge man in charge of the boat can do just as good work just as cheaply for a government engineer as he can for any dredge owner, and the great convenience and simplicity of having the dredges always available, so that they can be sent from point to point immediately when needed without spending thirty days in advertising for a farcical competition, give such advantages that the government will probably never return to the contract system of dredging except in unusual cases.

This need not be much of a hardship to the dredging interests, for there is probably ample private dredging to keep them all occupied, but pooling advantages are not so manifest in private work as they are when the government foots the bills.

Very truly yours,
CASSIUS E. GILLETTE,
Consulting Engineer.

1031 Land Title Building,
Philadelphia, Pa., April 4, 1908.

[A copy of Major Gillette's letter was submitted to Mr. Ryan, who has sent us the following reply. Much that he writes applies likewise to Captain Bond's criticism.—Editors.]

Sirs:

Absence from the city has prevented me from acknowledging earlier the receipt of yours of the 8th instant, enclosing me copy of letter of Major Cassius E. Gillette of April 4, in which the latter comments upon that portion of my argument prepared for the Rivers and Harbors Committee, and which was published in your issue of April 1 under the title "A Protest Against Government Ownership of Dredges."

Major Gillette says, among other things, that whilst the principles enunciated in my protest are interesting they do not cover the whole subject, the inference being that I have withheld important considerations in the discussion of the question, and which he attempts to supply by practically charging the private dredging contractors with collusion, or, as he puts it, "banding themselves together," thereby preventing legitimate competition, with the result "that the government will probably never return to the contract system of dredging except in unusual cases."

With conditions as they existed some years ago I am unable to speak with any definite knowledge, but during the past four years, or the period covering my connection with the dredging business, I can say with positiveness and absolute truth that there are no such associations to control prices as he refers to, apportioned to embrace the four geographical subdivisions of the Atlantic, great lakes, gulf and Pacific.

As an evidence of the correctness of this statement I need only mention the fact that, at this writing, dredging plant from the Atlantic coast is now at work upon government contracts at Galveston, Texas, whilst similar equipment from the gulf is engaged in harbor improvements at Providence, R. I., Norfolk, Va., and Baltimore, Md., none of which conditions would exist if there were collusion among the dredge owners, and more especially, to use Major Gillette's own words, as "towing them (dredges) long distances is an expensive and difficult operation."

The fact is that these respective dredging plants were transferred at great expense from the localities of their home ports, in the territory contiguous to which they would naturally prefer to operate, only because there was *bona fide* competition, and the lowest bidder secured the work.

Speaking of associations, the only one with which I am familiar is the Dredge Owners' Protective Organization, composed of operators on the gulf, Atlantic and Pacific coasts, which was organized solely to resist the onslaught of the government upon the business of the private dredging contractor in its apparent determination to continue the policy of building dredges for government account.

Major Gillette very properly divides dredging into two classes—ocean bar dredging and harbor dredging. I think, however, he is in error when he says that as to the former the government would be at the mercy of the dredge owners if there were only enough private dredges to do this class of work, for he ought to concede a sufficient enlightened selfishness upon the part of the dredgeman to know that he could only hope for occupation at fair and reasonable prices.

As an evidence of the enterprise of the private contractor and his willingness to risk considerable capital even in the special type of dredges used upon this bar work, it may be proper to say that I know of at least two government contracts for bar dredging that are now being executed by private contract, presumably at prices satisfactory to the government, one at York Spit Bar, lower Chesapeake Bay, where two such dredges are employed, and one at Brunswick, Ga.

The excessive cost of the sea-going dredge, and its comparative limited use, will probably pre-empt this field to the government, without serious dissent from the private dredging interests. Indeed, in so far as I could speak for them I think my statement—"Whilst we are willing to concede that in exceptional cases, where bars and shoals are formed with great uncertainty and rapidity, and navigation is consequently unexpectedly obstructed, the government is justified in having its own equipment in such localities for such emergencies"—shows that we are not unreasonable where the conditions would be exceptionally onerous to the government.

I do not think Major Gillette's reasoning is conclusive when he says if there were enough dredges to give competition on the ocean bar work the government would have to pay the expenses of even the idle ones, for there are idle dredges (for harbor work) now in all localities, and yet the truth is that notwithstanding the prices of labor, materials, and supplies have been steadily advancing for the past decade the unit cost of dredging to the government has been gradually declining, even with increased depths the rule, because there has been genuine competition.

Nor should it be forgotten that the idle dredges of the government—and these seagoing dredges cost $400,000 a piece—would cost something to maintain as well under government as private ownership, and that the alleged cheapness of so-called field cost is more apparent than real, as the government never adds anything for the cost of depreciation, slopes, or overdepths, but always makes it appear that its operations reach a 100 per cent efficiency, and are faultless in their observance of the specifications.

For the general reasons given in my argument I think Major Gillette is in error when he expresses the opinion that the government can execute work as cheaply as the private contractor, but even if he is correct in his contention—and the excessive cost of the printing bureau in contrast with private work is a convincing reason that he is not—still, as I say in that portion of my argument which you did not publish: "The government would not be justified, even if it were supported by the facts, which it is not, for this radical action, upon the claim of mere cheapness, for this argument can be applied with equal force to all the supplies, materials and construction work necessary for its maintenance, and logically the spectacle would present itself of the United States running shoe and clothing factories, saw mills and brick yards, slaughter houses and bakeries—in fact, the absorption of the private enterprises of the whole country, and the veritable adoption of socialism in all of its nakedness."

Whilst I am conscious of the eminent services Major Gillette has rendered his country and his profession by his fearless exposure of an unworthy fellow officer, and justly praise him for it, I fear that perhaps his experience in that particular case left his mind with a bias against the private contractor. If so, I want to say to him that private contractors are just like other groups of men, some good, some bad, some a mixture of both, and that the whole body should not be charged with moral turpitude because a few are delinquent, nor should they be regarded as conspirators seeking to mulct the government at every favorable opportunity.

All the reputable dredging contractors ask is a square deal. They welcome competition, under fair and reasonable specifications, but they protest against the government, of which they are a part, singling them out for destruction upon the false assumption of mere cheapness.

Yours very truly,
W. P. Ryan,
Secretary,
Dredge Owners' Protective Organization.
Baltimore, Md., April 16, 1908

Data on Street Dust.

Mr. H. DeB. Parsons, Dr. Rudolph Hering and Mr. Samuel Whinery, who were appointed on a special commission by the mayor of New York to investigate the subject of street cleaning, give the following information in their report on the dirt appearing in the streets.

Street dirt is found upon the streets under two distinct physical forms, though both have the same origin and are of the same general composition.

Much the greater part of the refuse which reaches the surface of the pavements consists orginally of coarse, and often damp, fragments, not readily taken up or blown about by ordinary breezes. In this primary condition, street dirt can hardly be said to endanger the health of the populace, nor is it the source of much discomfort or damage. Even the fresh excrement of horses and germs of disease expectorated upon the street are not usually a source of infection while in a fresh and damp condition. If, however, the accumulated refuse be allowed to remain, it will in time become finely pulverized by the action of the feet of horses and the wheels of vehicles. In this secondary condition it is street mud or slime in wet weather and street dust in dry weather.

A layer of slimy mud covering the streets acts as a lubricant between the pavement and the feet of horses, rendering the most desirable pavements—those with a continuous smooth surface—dangerous for the passage of horses, and greatly diminishes the loads that can be hauled. It pollutes the feet and clothing of human beings, and it is thus carried into residences and offices, where, after it becomes dry, any disease germs it contains may find lodgment in the lungs and blood of the occupants.

In the form of street dust it is a serious menace to health and a destructive and discomforting element of city life. Disturbed by street travel and carried about by even slight breezes, it is drawn with its disease germs into the lungs, and it permeates every crack and cranny of homes and business houses, damaging costly furnishings, clothing, and delicate goods, to say nothing of annoyance and discomfort.

Notwithstanding these facts, the efforts of the street cleaning departments of nearly every city are principally directed to the removal of street dirt in its gross or primary form; or rather the methods of cleaning in common use remove only the coarser fragments, leaving the mud and dust upon the surface of the street.

In order to ascertain the quantity of this neglected and dangerous material left upon the streets by the ordinary methods of street cleaning, we made a number of detailed examinations. The regular sweepings by the department preceding our examinations were done at least as well as the average of such work, and the streets appeared to be in a comparatively satisfactory condition of cleanliness. Directly after the streets had been swept by the ordinary methods, areas of street surface were measured off, carefully swept by special means, and the material left by the sweepers, consisting mostly of dust, collected, measured and weighed. The results are shown in the following table:

						Quantity of sweepings obtained.		Computed quantities per 1,000 sq. yds.		
Kind of pavement	Date of last turn	Method* of cleaning street	Travel	Area† swept, sq. ft.	Date of trial	Volume in cu. ins.	Weight in ounces	Volume in cu. ft.	Weight in lbs.	Weight per cu. ft.
Asphalt	Aug. 18	Hand	Light	300	Aug. 21	5.3	1.94	0.092	3.63	39.5
Asphalt	Aug. 18	Hand	Medium	400	Aug. 22	15.8	9.69	0.206	13.65	66.2
Block asphalt	Aug. 18	Machine	Light	300	Aug. 23	33.0	20.13	0.573	37.75	65.9
Block asphalt	Aug. 18	Hand	Light	300	Aug. 23	34.0	20.63	0.590	38.70	65.6
Asphalt	Aug. 24	Hand	Heavy	400	Aug. 29	49.8	21.88	0.648	30.77	47.5
Asphalt	Aug. 24	Machine	Light	300	Aug. 29	47.8	19.13	0.830	35.83	43.2
Granite block	Sep. 5	Hand	Heavy	400	Sep. 6	369.8	136.00	4.802	191.25	39.8
Wood block	Sep. 11	Hand	Heavy	300	Sep. 13	85.0	16.19	1.476	30.25	20.6
					Average			1.152	47.74	48.5

*Regular sweeping by department. †Area swept by commission.

This table is of special interest, and some remarks relating to it seem appropriate. It will be observed that the smallest quantity of dust collected by the special sweeping was at the rate of nearly 0.1 cu. ft. per 1,000 sq. yds. of pavement. The largest quantity found was at the rate of 4.8 cu. ft. per 1,000 sq. yds. The difference in effectiveness of hand (patrol) sweeping and machine sweeping is apparently not very great, but is in favor of the hand sweeping. There is a marked difference between the quantity of dust left upon pavements of various kinds. Thus, if we call the average volume and weight collected from the sheet asphalt pavement 100, the relative quantities from other kinds of pavement were:

	Volume.	Weight.
Sheet asphalt	100	100
Block asphalt	130	182
Wood block	332	145
Granite block	1,081	912

It should be said that the block pavement on which the examination was made is one of the oldest of its kind in the city, and its surface, being uneven, caught and held an unusual quantity of dust. Wood block pavement, when comparatively new, should compare favorably with asphalt block pavement in its freedom from dust retaining qualities.

This comparison, while interesting, must be regarded as approximate, since the number of examinations made was not large enough to warrant general conclusions; but it is obvious that the block pavements, with their frequent joints, offer a better lodgment for dust than pavements with a continuous smooth surface.

It is obvious that any method of street cleaning which does not remove with reasonable effectiveness this dangerous form of street dirt fails to accomplish the purpose for which cleaning is designed.

Results of Tar and Oil Road Treatment Experiments Made in Jackson, Tenn., in 1905.

In 1905 experiments on the treatment of macadam streets and country roads with tars and oils were made at Jackson, Tenn., under the supervision of Mr. Sam. C. Lancaster, City Engineer.

In preparing for the treatment the road surface was first swept with a horse sweeper and loosened with spikes in a 10-ton steam roller. The surface was then sprinkled and rolled. An average quantity of 0.45 gallon of tar per square yard was used in the experiment. The tar was placed on the road from a wagon at a temperature of from 160° to 190° F. by means of a 1¼ in. rubber hose with a nozzle of 1 in. pipe flattened at the end to deliver a broad stream. Laborers with street cleaning brooms of bamboo spread the tar evenly and quickly in a layer only thick enough to cover the surface. Under a hot sun the road absorbed practically all the tar in eight or ten hours, and a light coat of clean sand or screenings was then spread and rolled. The tar used came from Alabama and was a by-product from the manufacture of coke. It was practically free from moisture. The tar cost 0.24 ct. per gallon delivered on the road, and the labor cost of applying it averaged from 0.56 ct. to 0.95 ct. per square yard on different pieces of work. After seven months' service, including the winter months, the roads and streets were in excellent condition, being hard and smooth, with a surface resembling asphalt except that it was more gritty. The tar not only formed a part of the surface but made a good bed with the macadam, sections cut from the street showing that it had penetrated for 1 or 2 ins. and filled the small interstices between the stones. A further report on these experiments is given in a circular issued April 20, 1908, by the U. S. Office of Public Roads. In this circular it is stated that the results of these experiments with tar have been, on the whole, very satisfactory. A levee road to which tar had been applied has suffered several breaks owing to a flood, and a street on which street car tracks are laid has suffered from the washing down of sand and earth from the ballast upon the tarred surface. All other places where tar had been applied were in excellent condition, with the exception of one street which sustains a heavy country traffic at all seasons of the year. This stretch of road is densely shaded and only a thin crust ever dries out. Wheels have picked up this thin crust and the tar has accordingly disappeared. No repairs have been made on the other streets which were treated with oil since the material was applied, and the absence of mud or dust on these roads is noticeable. The dust is blown off the surface and the small amount of mud that forms is washed away by each rain.

About seven miles of streets and roads were sprinkled with oil, several grades of oil, varying in quality from a light crude oil to a heavy residuum being used in the experiment. About 0.48 gallon of crude oil was applied per square yard and 0.71 gallon of residual oil per square yard. The crude oil was applied cold, but the other oils were treated. The cost of the applications was as follows: On a city street with 0.48 gallon per square yard the labor was 0.57 to 0.78 ct.; on a country road, with 0.38 gallon per square yard, the labor cost was 0.33 ct. per square yard.

The circular previously mentioned also gives a further report on the experiment with oils. According to the circular no further treatment or repairs have been made to these roads. It is also stated that the crude and steamer oils have left no appreciable effects, but that good results are still apparent where the roads were treated with the residual oils. The latter roads are still practically dustless and all washing has been prevented.

Personals.

Mr. Walter B. Snow, Publicity Engineer, has removed to larger quarters at 170 Sumner St., Boston, Mass.

Mr. C. E. Leonard, of Austin, Tex., has been appointed City Civil Engineer of Taylor, Tex.

Mr. A. J. Reef has resigned his position with the Construction Department of the H. C. Frick Coke Co., at Scottdale, Pa., and has accepted a position as Field and Construction Engineer with the Oak Hills Coal Co., of Denver, Colo.

Lieutenant Carlos J. Stolbrand, Corps of Engineers, has been relieved from duty with the First Battalion of Engineers and in the Philippines Division, and will proceed to Washington Barracks, D. C., for duty with Second Battalion of Engineers.

Mr. E. L. Dalton has resigned his position as City Engineer of Dallas, Tex., and has opened an office in the Juanita building, that city, where he will engage in a general engineering practice. Mr. Dalton has been connected with the Engineering Department of the City of Dallas for nearly 20 years.

Mr. W. D. Waltman, Assistant Superintendent of Construction of the Culebra Division, Isthmian Canal, has been appointed Superintendent at Porto Bello. The Porto Bello project is to furnish all crushed stone necessary for the concrete work for the Gatun Locks. His address is Porto Bello, via Cristobal, Canal Zone.

Mr. D. A. Calhoun has become associated with Messrs. Caccavajo and Pruyn, Consulting Engineers, and the firm name is now Caccavajo, Pruyn & Calhoun, with offices at 2 Rector St., New York. Mr. Calhoun has been principally connected with railroad work, both as locating engineer and in charge of construction, which includes work in the United States, Philippine Islands and Mexico and South America. The firm has also become associated with Dr. Louis Duncan and Lamar Lyndon, Consulting Electrical Engineers.

Mr. Baxter L. Brown, of St. Louis, Mo., has been appointed Chief Engineer of the Terre Haute, Robinson & Olney R. R., which proposes the construction of a 100-mile line between the Wabash River and Mount Vernon, Ill.

Arthur Koppel, of the Arthur Koppel Co., died at Baden Baden, Germany, on May 12, in the 57th year of his age. Mr. Koppel was born in Dresden, but lived all of his life in Berlin. He was not technically educated, but at an early age engaged in the structural steel building. In this way the idea came to him of building portable tracks for various uses. The first were built of second-hand materials, and were so successful for contractors, factories and plantations that a plant was erected to begin the manufacture of "Industrial Railways," which name was given to them by Mr. Koppel. Then came the manufacturing of cars for use on these railways. The business grew from its inauguration in 1876 in Germany until to-day the company has factories in Germany, France, Russia, Spain and America, and offices and agencies in every country of the world. Prior to 1905 the business was run as a firm, but in that year it was incorporated as a stock company. An extensive plant was built at Koppel, Pa., at that time. Mr. Koppel is survived by a wife, a daughter and three sons, the eldest of whom is in charge of the company's business in New York.

Arthur Koppel.

Walter G. Berg, Chief Engineer of the Lehigh Valley R. R., died suddenly May 12 in New York, aged 50 years. Mr. Berg's first engineering work was with the Delaware Bridge Co. as draftsman and bridge engineer; from 1880 to 1881 he was engineer of bridges of the Richmond & Allegheny R. R.; 1881 to 1882, engineer in charge of the same road; 1882 to 1883, principal assistant engineer of the East Tennessee, Virginia & Georgia R. R. In 1883 he entered the service of the Lehigh Valley R. R. and continued in the employ of that company until his death. Mr. Berg was a member of the American Society of Civil Engineers, Roadmasters' and Maintenance of Way Association, past president of the Association of Superintendents of Bridges and Buildings, and president of the American Railway Engineering and Maintenance of Way Association. He was the author of numerous works on railroad engineering, among them being "Bridges and Buildings of American Railroads," "Buildings and Structures of American Railroads," "Shops and Roundhouses," "Classification of Maintenance of Way Accounts," etc. Mr. Berg was a charter member of the Maintenance of Way Association, and was the first chairman of its committee on "Buildings." In 1904 he was elected a member of the board of direction; in 1906 he was elected second vice-president, advancing to first vice-president in 1907, and in 1908 was elected president. To Mr. Berg belongs the credit of the "Manual of Recommended Practice for Railway Engineering and Maintenance of Way Work," issued by the Maintenance of Way Association.

Special Prices

1 Model 60 Marion, nearly new	$5,800
2 Porter, 9 x 14 Dinkeys, 36-inch gage, used 6 mos	1,700
2 Dickson, 10 x 16 Dinkeys, 36-inch gage, used 3 mos	2,200
1 Bucyrus, 65 ton, right from shop, overhauled	6,000
1 Bucyrus, 70 ton, used 8 mos	7,250

Immediate delivery

NEW OLIVER DUMP CARS 1 to 20 yard.

FRED. A. PECKHAM, 1301-2 Great Northern Bldg., CHICAGO.

STEAM SHOVELS and LOCOMOTIVES for rent.

CONCRETE BRIDGE.

Norwalk, Ohio.

Sealed proposals will be received by the Board of County Commissioners of Huron County, Norwalk, O., until 12:00 noon, June 4th, 1908, for the construction of a reinforced concrete Arch Bridge, over the Vermillion River, at Wakeman, Ohio.

The bridge will be of the ribbed, three hinged, open spandrel type, 145 feet span center to center of end hinges and 220 feet long over all. The roadway will be 18 feet wide.

Plans and specifications are now on file at the office of the Commissioners of Huron County, at Norwalk, O., and also at the following places:

Wilbur J. Watson, Consulting Engineer, Citizens' Bldg., Cleveland, O.

Builders' Exchange, Cleveland, O.

Builders' Exchange, Norwalk, O.

Engineering News, 220 Broadway, New York City.

Engineering-Contracting, 355 Dearborn St., Chicago, Ill.

Plans and specifications may also be procured from the Consulting Engineer upon the payment of five dollars per set.

Proposal blanks must be made upon blanks which may be procured at the office of the County Commissioners or from the undersigned.

Each proposal must be accompanied by a certified check, on a bank of good standing, in the sum of five hundred dollars, as a guarantee that if the bid is accepted, a contract will be entered into. The Contract Bond will be for five thousand dollars. Certified checks will be returned upon the acceptance or rejection of the proposal.

The right to reject any or all bids is reserved by the Commissioners.

WILBUR J. WATSON,
Consulting Engineer,
Citizens' Building, Cleveland. O

May 9, 1908.

MISSISSIPPI RIVER COMMISSION, 1st and 2d Districts, U. S. Engineer Office, Room 20, Custom House, Memphis, Tenn., May 11, 1908. Sealed proposals, in duplicate, for about 205,000 cubic yards of levee work in Upper St. Francis Levee District will be received at this office until 12 o'clock, noon, June 10, 1908, and then publicly opened. Information furnished on application. WM. D. CONNOR, Capt. Engrs.
20-4t

SEWERS.

Johnson City, Tenn.

Sealed proposals will be received by the Recorder until 3:30 o'clock p. m., May 28th, for the construction of a main sewer, about 5,000 feet in length (size 18-inch to 24-inch), and one sub-main sewer, about 2,200 feet long (size 8-inch to 15-inch), with all manholes, Y's, etc., according to plans and specifications on file in office of City Engineer.

Certified check in the sum of $500 must accompany all bids. City reserves right to reject any or all bids. Specifications may be had of the City Engineer. Bids will be opened at 7:30 p. m., May 28th, in open council meeting.

E. E. ELLSWORTH,
Recorder.
L. N. WILSON, JR.,
City Engineer.
21-1t

STATE ROAD WORK.

Baltimore, Md.

Sealed proposals addressed to the Chief Engineer of the Maryland Geological Survey, Baltimore, Maryland, endorsed "Proposals for Improving State Road No. 1, Section 9" will be received up to 12 o'clock noon, Saturday, May 23rd, 1908, when they will be publicly opened.

All proposals must be made on forms furnished by the Maryland Geological Survey, to be obtained through its office in Baltimore. Bids otherwise made out will not be considered.

The work to be done includes the grading and macadamizing of about three miles of road to be built according to the plans and specifications on file at the office of the Survey.

Each proposal must be accompanied by a certified check for two hundred dollars ($200.00), payable to the Maryland Geological Survey, which will be returned unless the successful bidder fails to execute a contract, in which case his check will become the property of the State.

The Survey reserves the right to reject any or all bids.

By Order of the Survey.

W. W. CROSBY,
Chief Engineer.
20-2t

BEST EXTENSIBLE TRENCHING BRACE MADE
KALAMAZOO F'DRY. & MACHINE CO
KALAMAZOO, MICHIGAN
598 EAST MAIN ST.

Trench Machines

We sell and lease all kinds of Hoisting and Conveying Machines for Trench Work

Catalogue sent upon request.

CARSON TRENCH MACHINE CO.
BOSTON, MASS., U. S. A.

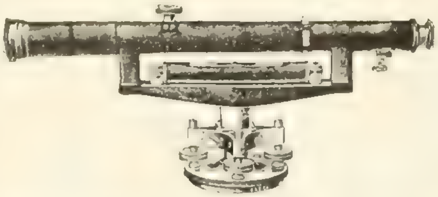
Branch Offices
101 Warren Street, NEW YORK
Park Building, CLEVELAND
299 St. James Street, MONTREAL

VULCAN IRON WORKS
CHICAGO
PILE DRIVERS

A Concrete

built with two boards by using the Dietrichs' Wall Form Clamps. The story is told in our BULLETIN E. Send for it.

THE DIETRICHS CLAMP CO.
15½ Kaufman Ave., LITTLE FERRY, N. J.



ENGINEER'S DUMPY LEVEL

FOR QUICK, ACCURATE WORK
FOR WORK ON ROUGH GROUND

A thoroughly reliable and accurate level of the finest workmanship. Erecting Telescope 18 inches, fine sensitive spirit level graduated on the glass, eyepiece adjustable vertically with patent Micrometer Focusing Arrangement with lock nut. Four Leveling Screws. Telescope bar and tube of spirit level cloth finish. The center is of the K & E Patent Construction. Split Tripod.

Our complete Catalog and Our Solar Ephemeris for 1908 (pocket size) Free on request.

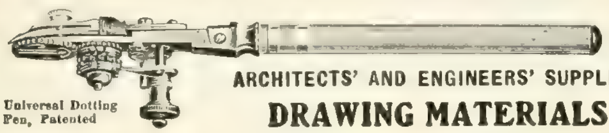
127 Fulton Street,
NEW YORK

KEUFFEL & ESSER CO.,

General Office and Factories
HOBOKEN, N. J.

CHICAGO—ST. LOUIS—SAN FRANCISCO

Drawing Materials Mathematical and Surveying Instruments Measuring Tapes



E. G. RUEHLE & CO. 119 Fulton St. NEW YORK Manufacturers and Importers

Universal Dotting Pen, Patented

ARCHITECTS' AND ENGINEERS' SUPPLIES
DRAWING MATERIALS

BUFF SURVEYING INSTRUMENTS

The "Buff" is built of metals which are so hard and tough that the shop-cost to machine is trebled.

Send for Catalog No. 3

BUFF & BUFF COMPANY, Boston, Mass.

F. D. CROFOOT N. NIELSEN

Printing by Electric Light

Crofoot, Nielsen & Company

BLUE PRINTERS

Blue Printing, Black Printing Blue Line and Color Printing

Special Service Always—Speed and RESULTS. Big Floor Space and Equipment for Rush Orders.

167-169 E. Washington Street, CHICAGO
Phone 759 Main

R. SEELIG & SON

172 E. MADISON ST., CHICAGO

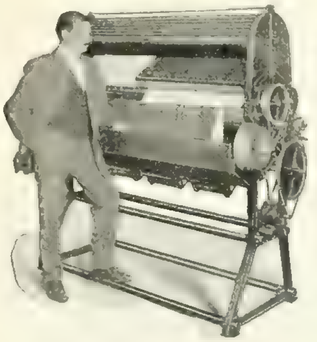
MANUFACTURERS OF MOST IMPROVED

ENGINEERING and SURVEYING INSTRUMENTS

Send for Catalog No. 6.

THE "TEC" DUPLEX

ELECTRIC BLUEPRINTING MACHINE IS THE ONLY MACHINE THAT COMBINES THE FOLLOWING SIX WONDERFUL FEATURES:



1. Two prints on different speeds of printing paper—a Vandyke print and a blue print—can be made at one and the same time.

2. Absolute perfect contact given by the rubber carrying band,—a vacuum contact.

3. Three prints can be made of one drawing if not too long, owing to the reverse action.

4. The machine, glass and tubes, can be cleaned while the print is going through—and a clean glass increases printing power 50%.

5. Machine is shipped in such compact shape that nothing remains to be done by the purchaser but insert the lamps and connect up with the feed wire.

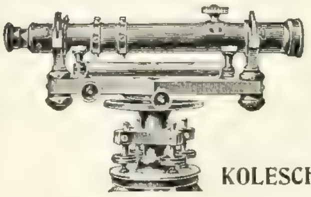
6. Will make prints of any length with perfect contact. No breaks or joints. No other machine will come within 100% of doing the work of the "Tec" Duplex, and to prove our assertion we will ship our machine on 30 days' approval to be placed in actual competition day by day with any other make—you purchase ours if we show results, or return at our expense.

The ELECTRICAL ENGINEERS' pocketbook, just out, 414 pages, profusely illustrated; bound in Morocco leather; round corners; gilt edges. A handy reference book for all persons interested in electricity, magnetism, dynamos and motors, electric lighting, interior wiring, power transmission, operation and maintenance of electrical apparatus.

Retail price, $1.50, special price to all answering this ad of $1.00. Cash must accompany all orders. Books sent subject to inspection.

Technical Supply Co.

53 East 14th St. New York



IS IT LEVEL?

The use of an Architect's Level assures you of correct results and saves time.
Our catalogue describes this and other useful instruments.

KOLESCH & CO., 142 Fulton St., New York

We Are
Manufacturers of
Contractors' and
Railway Supplies.
Write for catalog "A"
Union Elevator &
Machine Co.
144-6 Ontario St.
Chicago

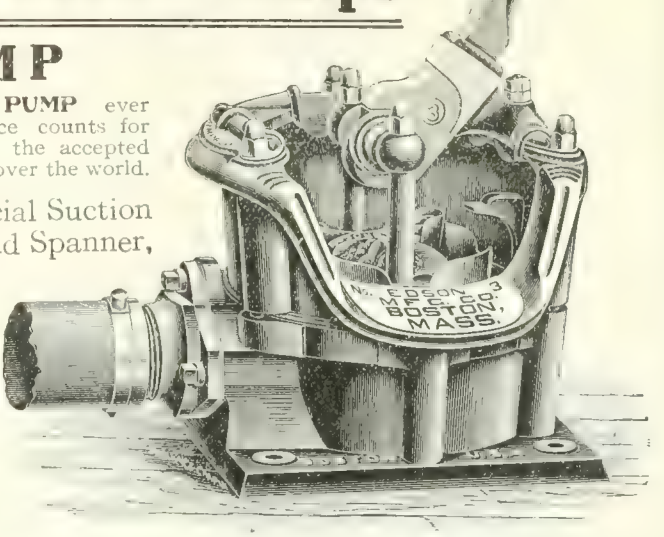
THE PEERLESS SWEEPER

For Sweeping Streets, Warehouses, Wharves, Etc.

J. S. BARRON,

Dept. 33, Franklin Street, and W. Broadway, New York

Eastern Agent for the Twentieth Century Grader



Edson Diaphram Trench Pumps

THE EDSON PUMP

was the FIRST **DIAPHRAGM PUMP** ever made. Experience counts for something. IT is the accepted STANDARD all over the world.

Complete Outfits, including Pump, Edson Special Suction Hose, Extra heavy Brass Couplings, Strainer and Spanner, **ready for business.** Extra lengths of **Suction Hose,** guaranteed **Diaphragms** and duplicate Pump parts, **carried in stock.**

SEND FOR DESCRIPTIVE CATALOG

Established 1859

EDSON MFG. CO.

256 Atlantic Avenue Boston, Mass.

225,000,000 - GALLON RESERVOIR AND DIVERSION SEWER.

Baltimore City Water Department,
Baltimore, Md.

Sealed proposals indorsed "Proposal for High Service Reservoir Construction, Baltimore City Water Department," addressed to the Board of Awards of Baltimore City, will be received at the office of the City Register, City Hall, Baltimore, Md., until eleven o'clock a. m., Wednesday, June 10th, 1908, for the construction of a High Service Reservoir and Diversion Sewer in connection therewith.

An approximate estimate of quantities is given below.

Plans and specifications, proposal form, etc., may be obtained at the office of the Water Engineer, City Hall, Baltimore, Md., on depositing five dollars ($5.00), which will be refunded on return of same.

All proposals must be accompanied by a certified check of the bidder on a Clearing House bank as a guarantee of good faith; the amounts to be as follows:

Proposals covering Item No. 1 or Items Nos. 1 and 2, five thousand dollars ($5,000.00).

Proposals covering Item No. 2 only, five hundred dollars ($500.00).

On awarding the contract, their checks will be returned to the unsuccessful bidders.

The successful bidder will be required to give satisfactory bond, equal in amount to the contract price for the faithful performance of the agreement.

Proposals are invited on either or both of the two items following, and the Board of Awards reserves the right to reject any or all bids.

Approximate quantities—Item No. 1:

Excavation from basin	687,000 cu. yds.
Excavation cut-off wall trench	22,000 cu. yds.
Rolled embankment	282,000 cu. yds.
Rolled or puddled clay in trench	9,000 cu. yds
Waste	400,000 cu. yds.
Reinforced concrete cut-off wall	2,000 cu. yds.
Top soil, spread, rolled, seeded	75,000 sq. yds.
48" reinforced concrete conduit	1,010 lin. ft.
Slope paving	23,000 sq. yds.
Gate house substructure.	
Gate vault.	

Item No. 2:

60" and 69" concrete diversion sewer	2,100 lin. ft.
18" vitrified pipe drain	350 lin. ft.

ALFRED M. QUICK,
Water Engineer

Approved:
J. BARRY MAHOOL,
President Board of Awards. 21-2t

MISSISSIPPI RIVER COMMISSION, 1st and 2d Districts, U. S. Engineer Office, Room 20, Custom House, Memphis, Tenn., May 16, 1908. Sealed proposals, in duplicate, for about 540,000 cubic yards of levee work in Upper and Lower St. Francis Levee Districts will be received at this office until 12 o'clock, noon, June 16, 1908, and then publicly opened. Information furnished on application. WM. D. CONNOR, Capt. Engrs. 21-4t

FOR SALE

Contractors' Equipment

32 H. P. Portable Boiler.
No. 0, No. 1, No. 2 Smith Mixers.
Single Drum and Double Drum Hoisting Engines.
½-Yard Cube Mixers.
½-Yard Ransome Mixers.
All Round Wiener Dump Cars.

Description on Request

Address, F. S. ROBINSON, 701 Owen Bldg., Detroit, Mich.

FOR SALE

At Mobile, Ala. Population, 80,000. Exports in cotton 1907, 522,925 bales, value per pound, 10.88. Postal business 1907, $167,388.86, 32 letter carriers, 5 trunk lines R. R. 17 steam ship lines. Business done in fish and oysters for 1907 and 1908, $2,025,000. Alabama coal used for business purposes, value $1,897,058. Lumber exported and manufactured here, $15,050,765. 165 miles water mains; 65 miles street car lines.

This is a 10-room farm house, good fencing, barns, 2½ acres land for truck or tobacco cultivation. Strawberry crop sold for $800.00. 5c car fare on interurban car line. Price, $3000; one-half cash, balance to suit at 5%. Please do not answer this unless you mean business, as the advertiser wishes to sell on fair, honest basis. Titles from King of Spain called Spanish Grant. 650 feet above Mobile river. Gulf breezes fan you always.

C. F. CULLEN, 62 S. Lafayette St., Mobile, Ala.

1353 Feet 3-inch Hole in 259 Hours?

Material Hard Basalt Rock. Average Record being made on Lorimer & Gailagher's work, Ellensburg, Washington.

1095 Feet 3-inch Hole in 274 Hours

Material, principally all Limestone. Work on Kentucky & Tennessee R. R. These are just AVERAGE RECORDS being made with CYCLONE SPECIAL CONTRACTORS' ROD DRILLS on Railroad and Quarry work.

Let us send you complete catalogs and full information regarding our BLAST HOLE DRILLS and LOADERS.

SEND FOR OUR SPECIAL CONTRACTORS' CATALOG AND COST BOOK.

The Jan.-Feb.-April issues of "The Drill Hole" contains detailed records of the above. SEND FOR THEM.

THE CYCLONE DRILL CO.

ORRVILLE, OHIO

WANTS

Undisplayed Cards under this heading cost only

One Cent a Word

Displayed $1.00 an Inch.

TECHNICAL MEN superintendents, engineers and draftsmen. Openings in all parts of the world at the highest possible salaries. Write us today of your experience. Hapgoods, 305 Broadway, New York City, or Suite 1012 Hartford Building, Chicago.

WANTED One small second-hand hoisting machine with double drum, all to be in good repair. Stone & Green, 1361 Monadnock Bldg., Chicago. 21-1t

WANTED Position Tunnel superintendent with complete organization. Soft ground, rock or compressed air. Open for engagement June 1. Address "Tunnel Supt.," care Engineering-Contracting, 13-21 Park Row, New York 21-2t

WANTED—Young man, technical graduate, experienced in concrete construction, desires position in designing, estimating, etc., for contractor, or consulting engineer. Address Box 30, care Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Technical graduate with 14 years' experience as constructing engineer in charge of large hydraulic and steel construction desires to change position. Address "Box 24," care of Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Position as assistant to contractor, or as general foreman. Am civil engineer, 32 years of age, with 12 years' experience in railroad, sewer, road, concrete and masonry construction. Address "T. S.," 3716 Ellis Ave., Chicago, Ill.

WANTED—POSITION—Young Civil Engineer, technical education, experienced on Railroad Preliminary Location and Construction. Heavy Masonry and general work wants position. Address "P. P.," care of Engineering-Contracting, 355 Dearborn St., Chicago. 3-tf

WANTED—POSITION by contractor's superintendent in general work. 25 years' experience in tropics and United States. Go anywhere. Open in June. First-class references. Address Box H, care of Engineering-Contracting, 13-21 Park Row, New York.

WANTED Position.—By young engineer with two years' experience in general field work and drafting. Good draftsman and instrument man. Position desired offering permanency of location. Assistant in city preferred. Address Box 35, care Engineering-Contracting, 355 Dearborn St., Chicago. 21-6t

WANTED Position as construction engineer or contractor's superintendent, by graduate civil engineer 28 years old. Five years' experience on design and erection of structures of steel and reinforced concrete. Best of references. Address Box 34, care Engineering-Contracting, 355 Dearborn St., Chicago. 21-1t

WANTED Will pay 15 cents each for one perfect copy of Engineering-Contracting for each of the following dates: July 3, 1907; July 10, 1907; August 7, 1907. These papers are wanted to complete files for binding. All reading pages must therefore be in perfect condition. Address "P. V. C.," care Engineering-Contracting, 355 Dearborn St., Chicago. 21-tf

WANTED—Position. Young man now employed, age 26. Good salesman and solicitor, having seven years' experience with engineers and contractors, desires permanent position in sales department of reliable firm handling contractors' supplies or a general line of construction material. Address Box 33, care of Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—POSITION — As superintendent, or general foreman on large construction work. Ten years' experience on public work. Experienced in excavation, earth and rock; heavy concrete construction, piers, abutments, retaining walls, dams, etc.; transportation of materials, etc. Possess executive ability to supervise large bodies of men; have handled successfully nearly every kind of labor used in the United States. At present employed; 32 years of age. Unmarried. First-class references. Address Box 29, care of Engineering-Contracting, 355 Dearborn St., Chicago.

Wanted to Buy

THEW STEAM SHOVEL

Address Box 32, care of Engineering-Contracting, Chicago, stating price and giving size of shovel.

FOR RENT

TWO K & E TRANSITS

Good Condition.

$8 a month to responsible parties.

D. B. METCALF,
48 Mt. Morris Bank, 125th Street, New York

STUDY OUR

CONCRETE

COURSES

Reinforced Concrete Design; Concrete Construction and Contracting, Plain and Reinforced; Manufacture of Cement Products, i. e. Blocks, Brick, Etc.

THESE courses are all meritorious. The latter teaches a new and scientific method of making concrete blocks, that gives as low as 4 per cent absorption and remarkable strength. Such blocks will win the favor of engineers; the cost is practically no higher. FREE CATALOG explains. Please indicate the course you are interested in.

CONCRETE ENGINEERING
584 Caxton Bldg., Cleveland

FOR SALE

1 Kearns **Revolving Excavator,** 1½ yard Orange-Peel Bucket, 65 ft. boom.

Two 36″ gauge **Saddle Tank Locomotives,** 12 ton.

One 15 ton, 36″ gauge **Saddle Tank Locomotive.**

New light rails and standard section **relayers** of all weights.

BLOCK-POLLAK IRON CO.,
Chicago Cincinnati St. Louis
Yards, East Chicago, Indiana

FOR SALE

Five-ton Northern, standard gauge, full circle

LOCOMOTIVE CRANE

with 25 ft. boom, now being rebuilt at Chicago shops and arranged to handle small clam or orange peel.

Ready about April 15th.
Will be good as new.

WILLIS SHAW
171 La Salle Street, Chicago

ESTABLISHED 1820

YOUNG & SONS

MANUFACTURERS OF

ENGINEERING MINING AND SURVEYING INSTRUMENTS

PHILADELPHIA

J. F. GRAHAM

(Roadmaster Graham)

RAILROAD LABOR AGENT

All classes of Laborers in Any Number

SUPPLIED FREE

Competent Foremen a Specialty.
Services Guaranteed Satisfactory.

WRITE OR WIRE

204 Washington Avenue South
MINNEAPOLIS, MINN.

CONTRACTORS AND ENGINEERS

SAVE LABOR

USE

Nash's Expeditious Measurer

A book of 200 pages of indexed tables, showing at a glance the cubic contents of any stone or package according to its length, breadth and depth. Used by Contractors, Quarrymen and Engineers everywhere. Order of your bookseller or the publisher. **$2.00 Postpaid.**

A. L. NASH
17 State Street NEW YORK
Send for Sample Pages

SAVE TIME

AVOID ERRORS

FOR SALE OR RENT

Two Vulcan **shovels,** 1½ yard and 2½ yard, 3 sets engines.

Two 42″ gauge saddle tank 9 x 14, **locomotives,** saddle tank.

Two 36″ gauge **locomotives,** saddle tank, 9 x 14.

30 and 56 lb. **relayers** with plates.

Traction engines, hoisting engines, pumps, etc.

HARPER MACHINERY COMPANY
1861 Fulton Bldg., Hudson Terminals,
50 Church Street, New York
Yards and Shops, Bloomfield N. J.

FOR SALE

1 Carson **Trench Machine.** Fine condition. Cost new $3,000.00. Will sell for.................. **$1,700**

1 ¾-yd. Smith **Mixer** on trucks, with engine.

10 1-yd. K. & J. **Scrapers.** Fine shape.

2 1½-yd. Oliver rotary **Cars. Cheap.**

1 8-wheel **Locomotive,** just overhauled and in fine condition. Price..... **$2,000**

Write us for anything you may be needing in the line of Contractors' equipment.

R. G. LUCAS & CO.
MARION, OHIO.

The Cincinnati Frog & Switch Co.
CINCINNATI, OHIO
Manufacturers of
Frogs, Crossings, Switches, Switch Stands, Rail Braces,
And special track work of every description for Railroads, Mines, Mills, Contractors, Plantations.

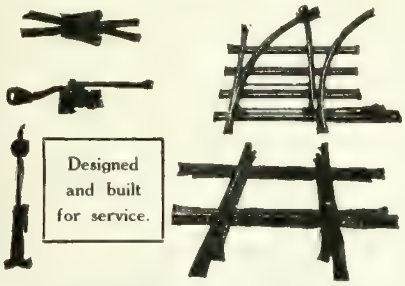
RARE BARGAINS in RAILS and EQUIPMENT
WALTER A. "ZELNICKER" SUPPLY CO.
in ST. LOUIS
Do you receive our Stock Lists?

Steam Shovels, Locomotives, Cars, Etc.
Contractors' and Railway Equipment
Telegraph, Telephone or Write Us.
A. C. TORBERT & CO.
547-548 Monadnock Block CHICAGO

LOCOMOTIVES
Eight 9x14 saddle tank 36-inch gauge. Also lighter and heavier locomotives. Have 165 locomotives from 6 to 70 tons in stock in our shops.
Also Steam Shovels
Southern Iron & Equipment Co.
ATLANTA, GA.

Tracklaying by Machinery
SIMPLE—RAPID—ECONOMICAL
D. F. HOLMAN
RAILWAY TRACKLAYER COMPANY
1101 Ellsworth Building, Chicago

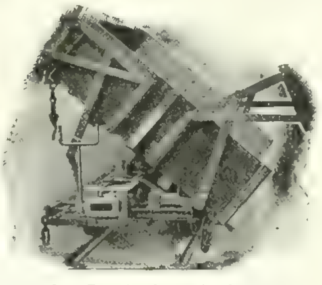
FROGS, SWITCHES, CROSSINGS
Stands and Portable Track for all weights of rail for Quarries, Mines, Coal Tipples, Industrial Plants and Contractors' use.



Designed and built for service.
Catalogue and prices upon request
THE INDIANAPOLIS SWITCH & FROG CO.
SPRINGFIELD, OHIO

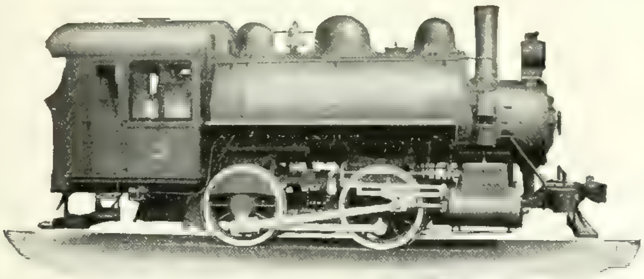
Largest Dealers in Rebuilt Equipment in United States
EAST WORKS
New Freight and Passenger Cars
WEST WORKS
Rebuilt Coaches, Cars and Engines
Hicks Locomotive & Car Works
General Offices Chicago Heights, Illinois
Sales Dept. Fisher Building, Chicago, Ill.
Eastern Representatives Empire Steel & Equipment Co., 141 Broadway, New York.

"CONTINENTAL" DUMP CARS



1½ to 20 Cubic Yards Capacity, any Gauge.
Continental Car & Equipment Co., (Inc.)
17 Battery Place, New York
Highland Park, Louisville, Ky.

LIGHT LOCOMOTIVES



For contractors, mines, plantations, industrial plants and light switching service generally.

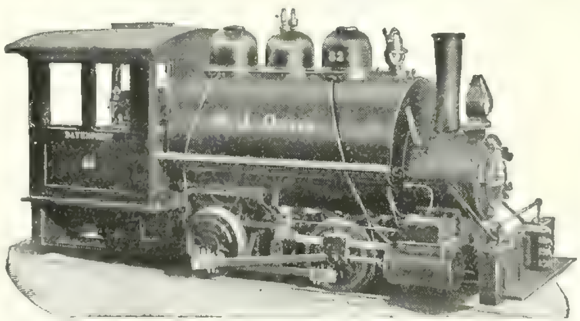
Standard types in stock for immediate shipment. Any desired design built to suit purchasers' requirements.

Interchangeable spare parts always on hand.

AMERICAN LOCOMOTIVE COMPANY
111 Broadway, New York

Davenport Contractors' Locomotives
Excel in Hauling Capacity as well as in working and wearing qualities—That's why so many contractors use them exclusively

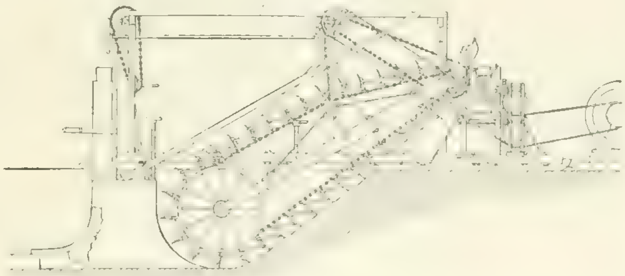
We build a contractor's locomotive—not merely a locomotive that can be used by contractors. This being our business, we have made it a point *to learn* by study and experiment the things that a contractor wants in a locomotive, and after learning, *to provide* these needed things in **Our Locomotive.** A contractor's locomotive has hard usage, and not the best care—good material and good workmanship are, therefore, essential, and we provide both. A contractor's locomotive must have hauling capacity—we guarantee **Davenport Locomotives** to haul more, size for size of cylinders, than any other. A contractor's locomotive has to be simple and easy to repair — **Davenport Locomotives** have interchangeable parts, and these parts are always kept in stock. We demonstrate all these claims in our Catalog "EC." Send for it, and if you are ever in Davenport come and see our plant—we feel proud of it.



DAVENPORT LOCOMOTIVE WORKS, Davenport, Iowa

It Digs the Ditch and Lays the Tile in One Operation

THE Hovland Tile Ditcher has been **perfected** upon actual tile drainage work. Being mounted on skids it will "stand" on the softest soil and either side can be raised or lowered to adapt it to sidling ground. It is self-propelling and can be steered in any direction. It has positively self-cleaning excavating blades and automatic discharge of the spoil to one side of the ditch. Unlike any other ditching machine it **lays the tile** as well as digs the ditch. Its speed of operation is from 100 to 200 feet an hour varying as follows: 10 ft. deep, 75 ft.; 7 ft. deep, 100 ft.; 4 ft. deep, 120 ft.; 2 ft. deep, 150 ft. Every detail of the machine is practical and efficient, and the machine is furnished under an absolute guarantee.



WRITE FOR PARTICULARS

ST. PAUL DITCHER & CARRIER CO.
ST. PAUL, MINN.

D. D. FORBES, President
W. B. KELLEY, Sec. and Treas.
JOHN F. BURCHARD, Vice-President

Own a Buckeye and Sub-Contract for Trenching.

MANY contractors who have bought a Buckeye Traction Ditcher have found it so profitable that they have ordered other Buckeyes, and do nothing but trench digging. Don't wait to get a sewer or a water pipe contract. Buy a Buckeye now and sub-contract for the trenching, no matter who gets the job.

With your Buckeye and two or three men you can do as much work as 100 laborers. There is always plenty of trench work to be had, at good prices, under sub-contracts. Buy a Buckeye and get busy. Our catalog will give you actual **costs of trenching** with Buckeyes. We make various sizes, digging up to 12 ft. in depth. No other trench machine can compare in strength and capacity with a Buckeye. Send for catalog "EC" and learn why.

If interested in farm drainage you want our drainage catalog. For open ditches with sloping banks, write for folder L.

The Buckeye Traction Ditcher Co.
Findlay, Ohio

USE THE

"Blaw System"

for centering your
concrete structures.

Write for CATALOG

**BLAW COLLAPSIBLE
STEEL CENTERING CO.**

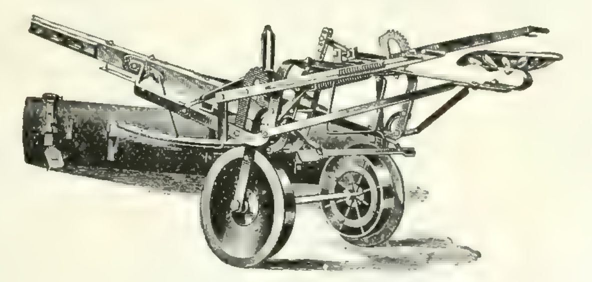
General Offices:
Westinghouse Building
PITTSBURG, PA.

Chicago Office: 1005 Chamber of Commerce Bldg.
New York Office: 320 Park Row Bldg.

This One-Man Grader Saves a Third to a Half

REASONS are numerous why the 20th Century Grader is a horse-flesh saver, an economizer of time, a preventer of worry and anxiety—600 pounds is light for so strong a machine which takes the place, (in three-quarters of the instances) of the two-ton, clumsy grader. What's the use of killing your horses when one man and a team can do the work quicker and easier, without the horses tearing out their insides.

Our 1908 Model has several unique and noteworthy features found on no other grader. Among them; flanged wheels, lever side-adjustment for pitch of blade, adjustable shoes on mold-board, etc. These and a score of other good reasons why you should own and operate a

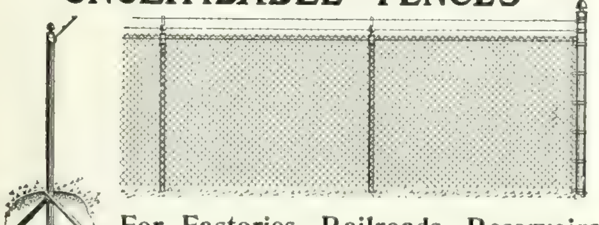


20th Century Grader

are told in our brand new booklet printed in orange and black, entitled, "20th Century Highways." This book tells how to make good roads out of bad ones, enumerates all the uses to which the 20th Century Grader can be put in constructing roads, railroad grades, irrigation ditches, for digging foundations for pavements, for leveling lawns, fields, etc., etc. It's valuable. Send now for it. It's free. Address

The Baker Manufacturing Co.
Dept. F, 706 Fisher Bldg. CHICAGO

UNCLIMBABLE FENCES



For Factories, Railroads, Reservoirs and Industrial Properties of all kinds

Manufacturers of Galvanized ANCHOR Posts, Iron Railings and Gates for all purposes.

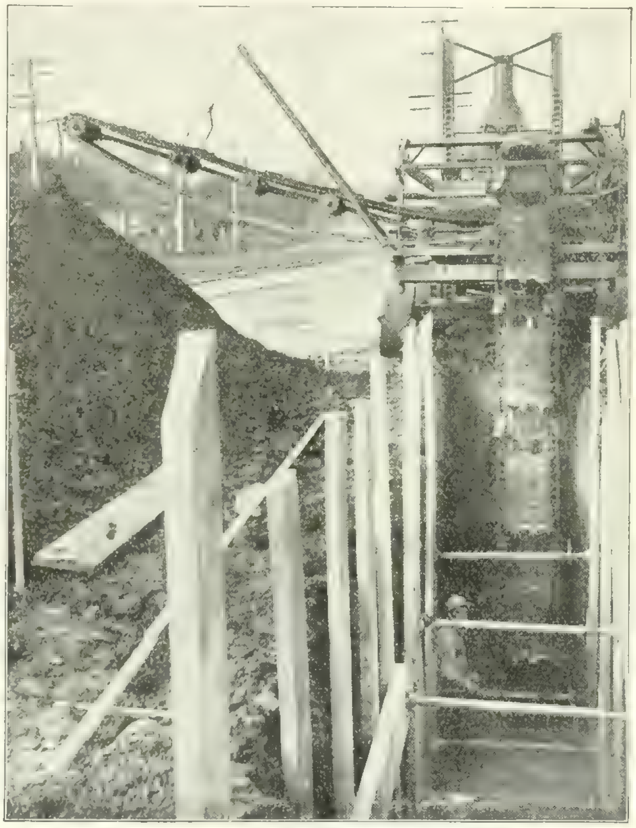
ANCHOR POST IRON WORKS, 149 Nassau Street
New York City

THE

Parsons Machine

FOR

Sewer Trenches and Water Mains.

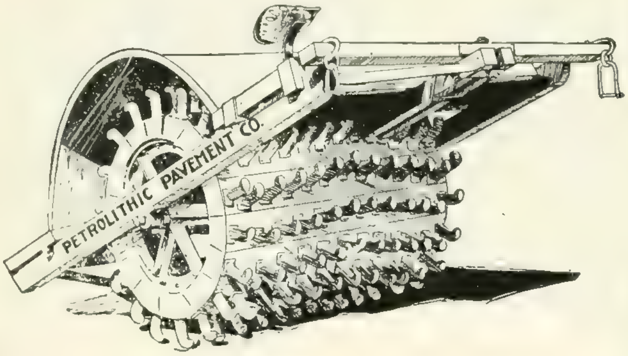


The Parsons Traction Trench Excavator, above illustrated, is a thoroughly practical, up-to-date machine, for the purpose of excavating trenches of any width between 28" and 60" and any depth up to and including twenty feet. This machine will make you money and will not be a continual source of worry. Write us.

GEO. F. LAMBERT, Sales Mgr.
306 Observatory Building,
DES MOINES, IOWA
Manufactured by
THE G. W. PARSONS CO.
NEWTON IOWA.

The Dustless Pavement —Petrolith

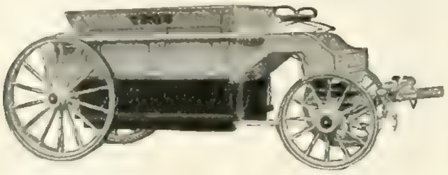
With the advent of automobiles, road and street designers have been confronted by a grave problem—the dust nuisance. Surface sprinkling and oiling has served to palliate the trouble, but can never cure the evil. An entirely new design of roadway is necessary. Petrolithic Pavement is designed to do away with the dust nuisance, and, incidentally, it has turned out to be the cheapest durable pavement ever devised. The process of making Petrolith consists in shaping the roadway, and in plowing the earth to a depth of about six inches. Then it is sprinkled with asphaltic oil or with any bituminous or tarry product suitable for the purpose. The soil and the oil are next mixed with a farm cultivator and then tamped with a Petrolithic Rolling Tamper. Oiling, harrowing and tamping are repeated until a pavement is produced that is almost as dense as an asphalt pavement, but free from dust and noiseless. It is ideal for residence streets and country roads, but has also been extensively used on business streets. Our large catalog illustrates numerous streets and roads and gives details of construction.


PETROLITHIC PAVEMENT CO.

Petrolithic Pavement Company

764 Pacific Electric Bldg., Los Angeles, Cal.

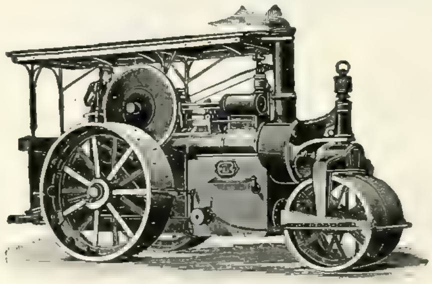
Road work will be done this summer on a larger scale than ever before. Few contractors, however, look into the problem of hauling as it should be looked into. The cost of hauling the materials alone is seldom less than 25% of the total cost of roadwork, and is usually much more. Troy wagons, with boxes of large capacity, and dumped in an instant, are bigger money savers than any other machine or tool that a contractor owns. How much will a Troy wagon hold? What does a Troy wagon cost? What makes the Troy wagon absolutely sand tight? We can not answer these and other questions in this space, but we have a catalog that you should send for and study, if you are at all interested in roadwork and in hauling generally. Ask for Catalog No. 2E.



The Troy Wagon Works Co.

295 South Walnut Street, TROY, OHIO

KELLY-SPRINGFIELD ROAD ROLLER CO.



Steam Road Rollers, All Types, All Sizes,
Over Eighteen Hundred in Use. Satisfaction Guaranteed.
Send for Catalogue No. 4

SPRINGFIELD, O.

PHILADELPHIA OFFICE, 2132 LAND TITLE BUILDING

NATIONAL DUMP WAGON

Send for Catalogue EC
INDIANA ROAD MACHINE COMPANY
FORT WAYNE, IND.

THERE IS ONLY ONE

Bitulithic Pavement, and that one is the Durable, Dustless, Sanitary and Non-Slippery street surface prepared and laid under the patented formulae and processes of Warren Brothers Company.

Bitulithic is the one smooth pavement that stands for Uniformity and Quality. It is the Ideal Roadway.

FULL INFORMATION FOR THE ASKING.

WARREN BROTHERS COMPANY
BOSTON, MASSACHUSETTS

Registered Trade Marks:
"Bitulithic" "Puritan" "Bituminous Macadam" "Bitrock" "Bitustone"

Some Advantages of
Creosoted Wood Paving Blocks

Smooth as Asphalt.

Durable as Granite Blocks.

Sanitary on Account of antiseptic treatment.

Noiseless to a greater extent than any other pavement.

Appeals to tax payers and contractors alike.

Capacity 3,000,000 yards a year.

Ayer & Lord Tie Company
1123—138 Washington Street
CHICAGO, ILL.

FRANK C. POWERS, Sales Agent

GULF REFINING CO.

REFINERS OF INDIAN TERRITORY AND TEXAS PETROLEUM

AN OILED ROAD IN CALIFORNIA.

Manufacturers
of
ASPHALT
for
PAVING
and
ROOFING

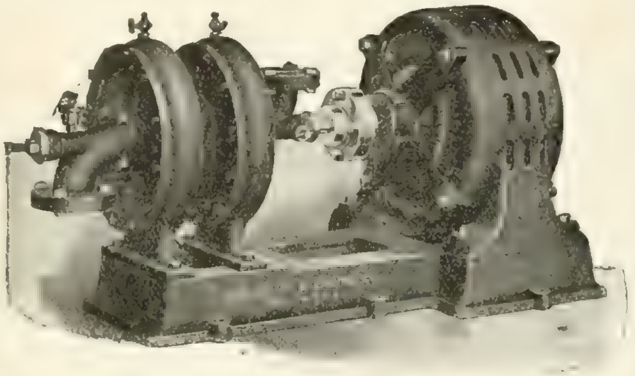
We Make a Specialty of Heavy Oil of Asphaltum Base for Oiling Roads

Prompt Shipments from Boston, New York, Philadelphia, New Orleans, Tampa, Fla., and Port Arthur, Texas.

GENERAL OFFICES: FRICK BUILDING ANNEX, PITTSBURG, PA.

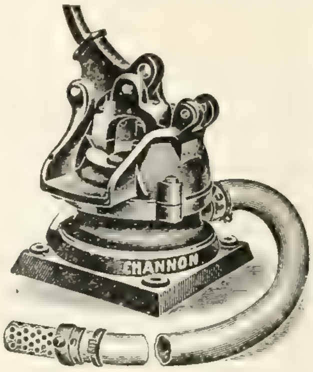
NEW ERIE TURBINE PUMP

OUR Turbine Pumps involve a new principle in pump construction. They give a high lift, with good efficiency. They will pump 10% of sand or grit without injury to the pump in any way. They are very compact and take small floor space. We connect them to gasoline and steam engines and motors or belt driven. We build EVERYTHING in Centrifugal Pumps both for dredging and water service. ASK FOR CATALOG "F" containing valuable information on centrifugal and turbine pumps and engines.



ERIE PUMP & ENGINE CO., ERIE, PA.

Channon Diaphragm Sewer Pumps



Used by contractors all over the country for handling dirty and gritty water on foundation jobs, sewer work and the like.

STANDARD No. 2 OUTFIT

Capacity about 3,500 gallons per hour with No. 2 Side Suction Pump, 12 ft. of 3-inch special rubber suction hose with couplings and strainer, complete. Price $35.00 net, Chicago.

Send for Catalog No. 33, fully describing above, as well as other Contractors' Equipment.

H. Channon Company.
Chicago.

25% More Water With the Same Power

or a given amount of water can be pumped with 25% less power than with old style centrifugal pumps.

Its a strong statement but we have proved it hundreds of times and we are ready to prove it again that—

On account of their being no sudden change of direction of the fluid when passing through the pump with a perfect cut-off near the outlet and the impeller being accurately machined to gauge on both sides and diameter and perfectly adjusted in the volute, it is impossible for the water to pass the impeller and churn in the casing in the

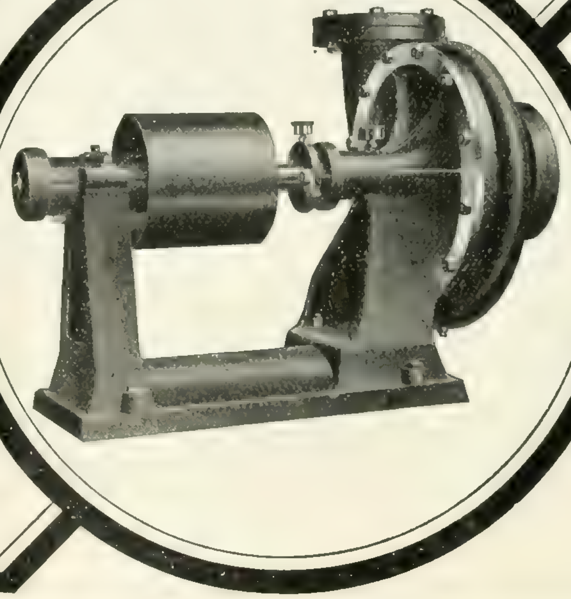
American Centrifugal Pump

and the entire mechanical action contributes directly to the highest possible efficiency, saving fully 25% of the expense of operation.

The unique design of the impeller enables the single stage pump to operate economically against high heads, saving the additional first cost and increased expense of operation of multiple stage pumps.

"American" Pumps are sold under a guaranty that they will give a mechanical efficiency of 60 to 80%, according to size, and that they will not use more power than is specified in our table of horse power required. There's a revelation in pump efficiency to engineers and contractors in our catalog and we mail it free on request.

The American Well Works,
General Office and Works, Aurora, Illinois, U. S. A.
Chicago Office: First Nat'l Bank Bldg.

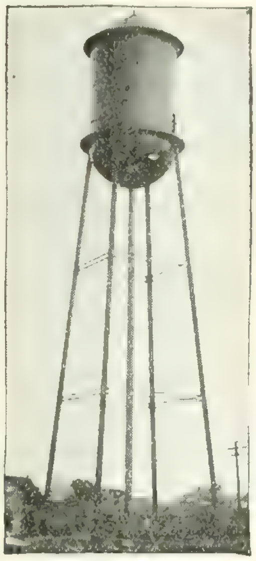


One Way to Save Money

If you are interested in the construction or operation of municipal water works, you can save money for the city by constructing an elevated tank on the system. This will give a uniform static pressure of any amount desired upon the mains, and cause a saving in cost of pumping which will pay for the structure in a very short time, besides affording fire protection which is independent of the operation of pumps for several hours. These illustrations show some of the tanks we have built for this purpose. The cuts are all made to the same scale and give some idea of their comparative sizes, the Louisville tank being the largest in the world. Write for illustrated booklet.

Chicago Bridge and Iron Works
Washington Heights Sta., Chicago.

Capacity 1,200,000 Gals.
Height 220 ft.
Louisville, Ky.
Louisville Water Co.



Capacity 200,000 Gals.
Height 157 ft.
Sycamore, Ill.
City Water Works

Cap'y 40,000 Gals.
Height 98 ft.
Greeley, Neb.
City Water Works

Cap'y 2,000 Gals.
Height 42 ft.
Belton, S. C.
Private Res.

Cap'y 60,000 Gals.
Height 85 ft.
Lock Haven, Ill.
C. P. & St. L. Ry.

McWANE-LYNCHBURG TRADE CAST IRON PIPE MARK "QUALITY BEFORE QUANTITY"

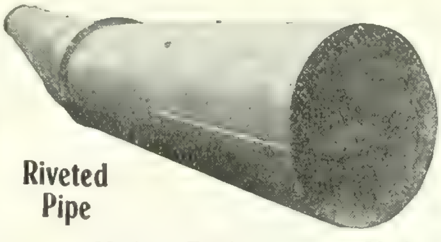
WATER AND GAS WORKS MANAGERS

WRITE FOR CATALOG OF

McWANE PIPE WORKS

LYNCHBURG, VA. NEW YORK CITY

STEEL TANKS AND PLATE WORK



Riveted Pipe

We Construct **Steel Tanks** For Any Purpose

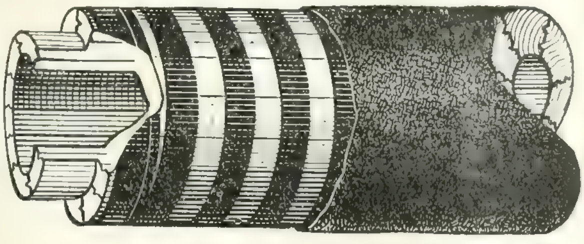
Modern Equipment Modern Methods
35 Years' Experience

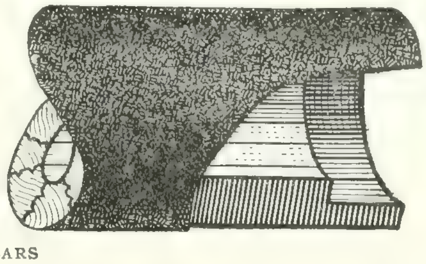
WM. GRAVER TANK WORKS, EAST CHICAGO, IND.

Improved Combination Steel and Wood Pipe

For Municipal Water-Works Systems, Mines, Railroads, Chemical and Iron Works

Strength of Steel
Will Not Rust
Easily Installed





Durable
Cheaper Than Iron Pipe
Keeps Water Conveyed Sweet

WRITE FOR CIRCULARS

THE MICHIGAN PIPE COMPANY, BAY CITY, MICHIGAN

CLASSIFIED DIRECTORY OF ADVERTISERS—(For location of advertisements see Alphabetical Index, page 8).

Air Compressors
American Well Works.
Ingersoll-Rand Co.

Architects' Supplies (See Engineers' Supplies, Instruments etc.)

Artesian Wells, Tools, Pumps
American Well Works.
Cook Well Co.
Feeley & Co., J. E.

Asphalt
Gulf Refining Co.
Standard Asphalt & Rubber Co.
Warren Bros. Co.

Automatic Stokers (See Grates, Traveling Link)

Ballast Unloaders and Spreader
Browning Engineering Co.
Marion Steam Shovel Co.

Bearings—Oilless and Self-Oiling
North Am. Metaline Co.

Blocks—Snatch and Tackle
Chisholm & Moore Mfg. Co.
Patterson Co., W. W.
Union Elevator & Machine Co.

Block Machines (See Concrete Block Machines)

Blue Print Apparatus and Paper
Am. Blue Print Paper Co.
Crofoot, Nielsen & Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.
Technical Supply Co.

Boilers
Graver Tank Wks., Wm.

Bolts
Scovil Mfg. & Supply Co.

Bolts—Expansion, Toggle, Etc.
Cleveland City Forge & Iron Co.

Books
Audel & Co., Theo.
Clark Pub. Co., Myron C.
Nash, A. L.
Technical Supply Co.

Boots for Contractors
Rubberhide Co.

Borings, Test (See Artesian Wells)

Bridges, Roofs, Trusses, Etc.
Chicago Bridge & Iron Wks.
Continental Bridge Co.
Page & Shnable.
Ransome Concrete Machy. Co.

Buckets—Coal, Ore, Dredging
Channon Co., H.
Cyclopean Iron Works.
Hayward Co.
Hough Co., Wm. B.
Kiesler Co.
Northern Engineering Works.
Page & Shnable.
Sackett Screen & Chute Co.
Tide Water Iron Works.
Wiener Co., Ernst.
Williams Co., G. H.

Cableways — Suspension Wire Rope
Balanced Cable Crane Co.
Flory Mfg. Co., S.
Harper Machinery Co.

Car Couplers, Fenders, Fittings, Car Wheels
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Cars
Contin'tl Car & Equip't Co.
Harper Machinery Co.
Hicks Locomotive & Car Wks.
Koppel Co., Arthur.
Peckham, Fred A.
Sackett Screen & Chute Co
Weiner Co., Ernst.

Cars—Tanks
Graver Tank Wks., Wm.

Carts for Concrete, Etc.
Archer Iron Works.
Hough Co., Wm. B.
Ransome Concrete Machy. Co.
Sackett Screen & Chute Co.

Carts and Wagons — Ash and Dump
Contractors' Sup. & Equip. Co.
Good Roads Machinery Co.
Hough Co., Wm. B.
Indiana Road Machy. Co.
Ransome Concrete Mach. Co.
Sackett Screen & Chute Co.
Studebaker Bros. Mfg. Co.
Troy Wagon Works Co.

Castings and Forging
American Casting Co.
Green Engineering Co.
Scovil Mfg. & Supply Co.
Tide Water Iron Works.
Vulcan Iron Works.

Cement
Atlas Portland Cement Co.
Chicago Portland Cement Co.
Edison Portland Cement Co.
Lehigh Portland Cement Co.
Marquette Cement Mfg. Co.
Universal Portland Cement Co.

Chains
Hayden-Corbett Chain Co.
Woodhouse Chain Works.

Chain Belts—(See Power Transmission Machinery)

Chimney—Iron and Steel—(See Boilers

Clevis Nuts
Cleveland City Forge & Iron Co.

Clocks
Prentiss Clock Co.

Coal and Ore Handling and Conveying Machinery, Etc.
Browning Engineering Co.
Brown Hoisting Machy. Co.
Channon Co., H.
Hayward Co.
Hough Co., Wm. B.
Koppel Co., Arthur.
Northern Engineering Works.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Collapsible Centerings
Blaw Steel Centering Co.

Concrete Block Machines
Brandell Conc. Blk. Mach. Co.
Miles Mfg. Co., P. B.

Concrete Made Refractory
Stowell, E. R.

Concrete Mixers and Machinery —(See Mixers—Concrete)

Concrete Work—(See Contractors; also Fireproof Construction)

Consulting Forester
Meier, F. R.

Contractors
Caton & Olmstead.
Christman, Edward.
Concrete-Steel Retaining Wall Co.
Continental Bridge Co.
Gilbreth, Frank B.
Jackson, Inc., Geo. W.
McGrath, M. P.
Rodgers Co.
Trussed Concrete Steel Co.

Contractors' Supplies and Equipment — (See also Second-hand Supplies)
Archer Iron Works.
Channon Co., H.
Contractors' Sup. & Equip. Co.
Harper Machinery Co.
Hough Co., Wm. B.
Koppel Co., Arthur.
Lucas & Co., R. G.
Peckham, Fred A.
Sackett Screen & Chute Co.
Scovil Mfg. & Supply Co.
Shaw, Willis.
Torbert & Co., A. C.
Union Eltr. & Mach. Co.
Wiener Co., Ernst.

Converters and Cooling Towers
Graver Tank Works, Wm.

Conveyors and Conveying Machinery—(See Coal and Ore Handling and Conveying Machinery)

Correspondence Courses in Engineering
Concrete Engineering.

Couplings—Friction Clutch
Brown Hoisting Machy. Co.
Browning Engineering Co.
Sackett Screen & Chute Co.

Cranes
Brown Hoisting Machy. Co.
Browning Engineering Co.
Northern Engineering Works.

Crayons and Pencils—(See Engineers' Supplies)

Creosoting
Ayer & Lord Tie Co.

Crossings—Railways (See Frogs)

Crushers and Pulverizers
Chicago Concrete Mchy. Co.
Good Roads Machinery Co.

Culverts
Crawfordsville Corrugated Culvert Co.

Derricks and Derrick Fittings
Browning Engineering Co.
Carson Trench Machine Co.
Contractors' Sup. & Equip. Co.
Flory Mfg. Co., S.
Northern Engineering Works.
Parker Hoist & Machine Co.
Terry & Tench Co.

Ditching Machinery, Steam Shovels, Etc.
Austin Drainage Excavator Co
Atlantic Equipment Co.
Brown Hoisting Mach. Co.
Browning Machinery Co.
Buckeye Traction Ditcher Co.
Carson Trench Machine Co.
Ellicott Machine Co.
Fairbanks Steam Shovel Co.
Flory Manufacturing Co.
Harper Machinery Co.
Hayward Co.
Hough Co., Wm. B.
Ingersoll-Rand Co.
Marion Steam Shovel Co.
Municipal Eng. & Contrg. Co.
Parsons Co., G. W.
Peckham, Fred A.
St. Paul Ditcher & Carrier Co.
Souther & Co., John.
Thew Automatic Shovel Co.
Torbert & Co., A. C.
Vulcan Iron Works.
Vulcan Steam Shovel Co.

Drafting Room Furniture (See also Engineers' Supplies)
Berger Mfg. Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.

Dredging Machinery (See also Ditching Machinery)
Ellicott Machine Co.

Drills—Core, Prospecting
American Well Works.
Cyclone Drill Co.

Drills—Rock and Ore
Cyclone Drill Co.
Ingersoll-Rand Co.
Wood Drill Works.

Dump Wagons (See Carts and Wagons

Dynamometers
Du Vivier, E. H.

Employment Agencies
Assoc. Union of S. S. & D.
Engineering Agency.
Graham, J. F.
Hapgoods.
Int. Bro. of S. S. & D'men.

Engineers—Civil, Consulting and Mechanical—(See Engineers' Directory)

Engineers' Supplies, Instruments, Etc.
Am. Blue Print Paper Co.
Buff & Buff Co.
Crofoot, Nielson & Co.
Keuffel & Esser Co.
Kolesch & Co.
Prince, L. M.
Ruehle & Co., E. G.
Seelig & Son, R.
Young & Sons.

Engines—Gas, Gasoline and Oil
American Well Works.

Engines—Hoisting
Brown Hoisting Mach. Co.
Channon Co., H.
Flory Mfg. Co., S.
Harper Machinery Co.
Hough Co., Wm. B.
Northern Engineering Works.
Reliance Mach. & Tool Wks.
Stroudsburg Engine Works.

Engines—Stationary and Pumping
American Well Works.
Channon Co., H.
Cook Well Co.
Erie Pump & Engine Co.
Harper Machinery Co.
Hough Co., Wm. B.
Stroudsburg Engine Works.

Engines—Traction
Harper Machinery Co.

Expanded Metal—(See Fireproof Construction)

Excavating Machinery — (See Ditching Machinery)

Fence and Railing
Anchor Post Iron Works.

Fence Posts—Iron
Anchor Post Iron Works.

Filing Cases (See Drafting Room Furniture)

Filters—Water
New York Continental Jewell Filtration Co.
Norwood Engineering Co.

Fireproof Construction
Berger Mfg. Co.
Calumet Steel Co.
Concrete-Steel Retaining Wall Co.
Hough Co., Wm. B.
Ransome Concrete Mach. Co.
Rodgers Co.
Trussed Concrete Steel Co.

Forms for Concrete Work.
Dietrichs Co., Charles.

Frogs, Crossings and Switches—Railway
Cincinnati Frog & Switch Co.
Indianapolis Switch & Frog Co.
Koppel Co., Arthur.
Weiner Co., Ernst. ... ...

Furniture and Office Fittings—(See also Drafting Room Furniture)
Berger Mfg. Co.
Keuffel & Esser Co.

Gauges—Recording
Du Vivier, E. H.

Graders and Scrapers — Earth (See Road Machinery)

Grates—Traveling Link
Green Engineering Co.

Grout Mixer and Injector
Tide Water Iron Works.

Hoists
Hayward Co.
Hough Co., Wm. B.
Ingersoll-Rand Co.
Ransome Concrete Machy. Co.

Hoists—Electric
Grable-Dunn Co.
Northern Engineering Works.

Hoists—High Speed Chain
Chisholm & Moore Mfg. Co.

Hose and Fittings
Ingersoll-Rand Co.

Hydrants
Norwood Engineering Co.

Industrial Railways
Cincinnati Frog & Switch Co.
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Inspection of Iron and Steel
Am. Bureau of Insp'n & Tests.
Conard, W. R.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, Chicago
Telephone Harrison 6770

NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt

BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . PRESIDENT
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):
$2.00 *a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
$2.50 *a year (52 issues) to Dominion of Canada.*
$3 00 *a year (52 issues) to all other countries*

ADVERTISING RATES ***sent on application.***
Copy for regular advertising must be received not later than Friday preceding date of issue in which it is to appear. "Proposals," "Wants" and "For Sale" announcements can be inserted as late as Tuesday morning.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

The Effectiveness of a Slogan in Advertising 315
The First English Association of Concrete Workers 315
A Reinforced Concrete Garage Having 75 ft. Girders 316
A New Wall Form for Concrete Buildings 317
The Electric Air Drill 318
A Combination Ditching and Tile Laying Machine for Farm Drainage . . . 320
The Municipal Asphalt Repair Plant of the Borough of Brooklyn and Data on the Cost of Operating It . . . 321
Method and Cost of Constructing a Telephone Line 324
Methods and Costs 323
Catalogs Worth Having 326

The Effectiveness of a Slogan in Advertising.

The main objects of an advertisement are:

First, to get the advertisement read; second, to get it remembered; and, third, to produce such a favorable impression that the reader will investigate further, either by sending for a catalog or by making inquiries that will lead to a purchase. Of course the ultimate object of all advertising is to sell products, but prior to selling must come (1) attention, (2) remembrance, and (3) investigation. In our last week's issue we indicated how to arrest attention by means of a properly worded caption, well displayed. There are many other methods of attracting attention, and we shall discuss some of them in our next issue. But we wish to speak now of getting people to remember your name or your product.

An advertising "slogan" is a concise, catchy expression intended to stick in the memory of the reader. "Good morning. Have you used Pears' soap?" was a slogan that had nothing brilliant to commend it, but persistent publication gave it a great vogue. At one time a person could seldom say "good morning" without being greeted by the rest of the slogan in reply. The merit of this slogan consists in connecting the name of the soap with a common expression of greeting; but nothing short of an expensive campaign of advertising could have brought about the desired result. On the other hand, a witty slogan, or one with rhythm and rhyme will frequently win recognition quickly, as does a popular song.

"A Kalamazoo direct to you" is a good example of a slogan that is likely to stick in the memory, because of its jingle. It also has the merit of having the trade name as a part of the slogan. However, many a good slogan contains no mention of the firm name or product, as "You press the button. We do the rest."

By advertisers in trade papers, slogans have never been used to the extent that their effectiveness warrants. "Fifteen minutes in hot paint gives a life of fifteen years" is an effective slogan, which most of our readers will have noticed, and, having noticed, are likely to remember. "In a Hurry? Send to Hough" is another, which, in connection with the numerous small line drawings of machines that accompany it, is likely not to be forgotten.

It goes without saying that a slogan must be repeated many, many times before it becomes the mental property of all the readers. After that result has been accomplished, it is frequently wise to subordinate the slogan, although retaining its use. The "57 varieties" of Heinz pickles are no longer as conspicuous in type as they once were, but no Heinz advertisement appears without that slogan somewhere in the text.

"The beer that made Milwaukee famous," "Cost-plus-a-fixed-sum contract," "His master's voice"—these and a score more will come to mind as slogans that have been of great assistance in successful advertising campaigns.

A few hints now on the preparation of slogans.

An antithesis is often used with excellent effect in any kind of epigrammatic writing. "You press the button, we do the rest," is antithetical; so, too, is "15 Minutes in Hot Paint Gives Life of 15 Years." "It Works While You Sleep" also comes under this head, and numerous others will be found by any one who studies the subject.

A pun, if clever—and a few puns are clever—may be used with effect in a slogan. A pun may be a play on ideas rather than a play on mere words. Of this class is the tailor's slogan, "It fits well around the neck," accompanied by a picture of a girl with her arm around a man's neck.

The use of rhythmic words in any expression is a great aid to memory, hence a slogan that is rhythmic (not necessarily rhyming) is less likely to be forgotten than one in which the words come without a measured beat. The simplest rhythm is the "iambic foot," consisting of an unaccented syllable followed by an accented syllable, as exemplified in the blank verse of Shakespeare, or Milton. At first sight it would not occur to a reader that "Good morning, have you used Pears' soap?" is blank verse, but it scans into iambic feet nevertheless.

"A Kalamazoo direct to you" is a slogan which exemplifies both rhythm and rhyme.

A little search will disclose many other rhythmic slogans, and a little thought will make it evident that to rhythm itself is due much of the adhesive effect of the language.

Most of Lincoln's Gettysburg oration and sentence after sentence from Webster's perorations are iambic blank verse, and the ease with which they are memorized is traceable to the rhythm of the language.

In our next issue we shall discuss the use of illustrations in technical advertising.

The First English Association of Concrete Workers.

The study of reinforced concrete in England is to be taken up in circumstance by the Concrete Institute, which has been organized with the Earl of Plymouth as president, Sir Wm. Muther, Sir Wm. Preece and Sir Henry Tanner as vice presidents, Mr. Edwin O. Sachs as chairman, Mr. E. P. Wells treasurer and Mr. A. E. Collins as secretary. The objects of the institute are: To advance the knowledge of concrete and reinforced concrete, and direct attention to the uses to which these materials can be best applied; to afford the means of communication between persons engaged in the design, supervision and execution of works in which concrete and reinforced concrete are employed (excluding all questions connected with wages and trade regulation); to arrange periodical meetings for the purpose of discussing practical and scientific subjects bearing upon the application of concrete, and to conduct such investigations and to issue such publications as may be deemed desirable.

We make note of this new society chiefly because we believe it is the first association of its kind in England. With a few notable exceptions English engineers have done surprisingly little toward the advancement of reinforced concrete as a structural material. The great bulk of the reinforced concrete work being done in England is being done by the agencies of American and continental European firms. There have been various reasons for this, chief among which are the antiquated building regulations which have made economical reinforced concrete building construction a practical impossibility. Concrete workers in America will welcome this new organization.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

A Reinforced Concrete Garage Having 75 ft. Girders.

There are many classes of buildings in which it is desirable to have a large open floor space unobstructed by columns or pillars of any kind. A few years ago a fireproof building of that kind could not have been built at moderate cost; but the development of the scientific design of reinforced concrete beams and columns has made it possible to construct a building of this character, like the one we are about to describe.

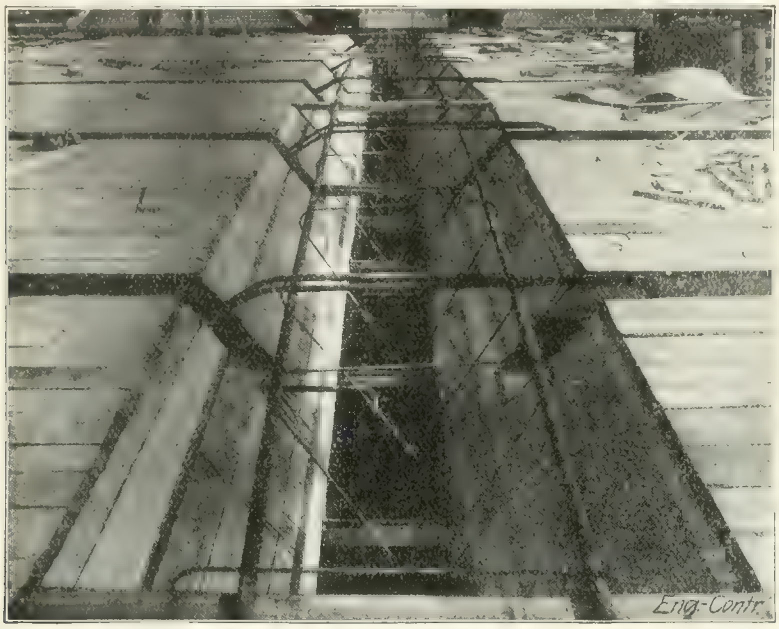


Fig. 1—View Showing Form for 75-ft. Span Reinforced Concrete Girder.

In this instance the owner wanted a garage having at least one large room 70 ft. wide and 120 ft. long where automobiles could be stored. In view not only of the value of the automobiles themselves, but of the danger from fires where gasoline is used, he insisted upon a structure fireproof throughout. The owner wanted no pillars between the side walls of this large room, thus compelling the designing engineer to provide girders having a span of 75 ft. These girders were built of reinforced concrete, and are among the longest girders ever built of this material. We shall refer to them again, but for the present let us consider the general features of this interesting building.

It is located at White Plains, N. Y., and is called the Mammoth Garage. Its name can not easily be forgotten by anyone who has once seen the three heads of mammoths that ornament the front of the building, particularly if they have been seen at night. Incandescent electric light bulbs form the eyes of the mammoths. The heads at present are not of concrete, but it is the intention to have heads of concrete cast to replace those now temporarily in position. Incidentally, we may add that both architects and engineers have failed yet to utilize concrete for ornamental purposes to the extent that is warranted by the excellence of the effect and the economy of the execution. As an instance, we recently saw some beautiful "bronze" statues, made of copper fillings, sand and Atlas Portland cement. A little acid had been sprinkled over the statues to oxidize the copper and produce the green verdigris characteristic of old bronze.

The front of this garage is finished with panel effects. The cornice and edges of the columns were washed with cement grout. Elsewhere the surface of the concrete on the front of the building was tool-dressed. This gives an excellent appearance.

The garage covers an area of 77 ft. x 260 ft. The front part is two stories high and contains offices, reception room, locker and supply rooms, baths, etc. The rear part is one story, and contains a machine repair shop. The central part of the building contains the large room above mentioned, 73 ft. wide by 120 ft. long, which is well provided with windows on both sides.

The girders that span this room have a cross-section of 18x75 ins. and are reinforced with 25 sq. ins. of steel, so that the reinforcement is not quite 2 per cent of the total area. The reinforcing rods are used without stirrups. The rods pass through plates, and are held by nuts. To hold these rods in place in the forms while pouring the concrete an ingenious method was devised. Bolts were put through the forms, from side to side, and these bolts supported the reinforcing rods. On each bolt was a sleeve of gas pipe, so that the bolt could be easily removed when the forms were taken down. The holes were plastered up with mortar. By

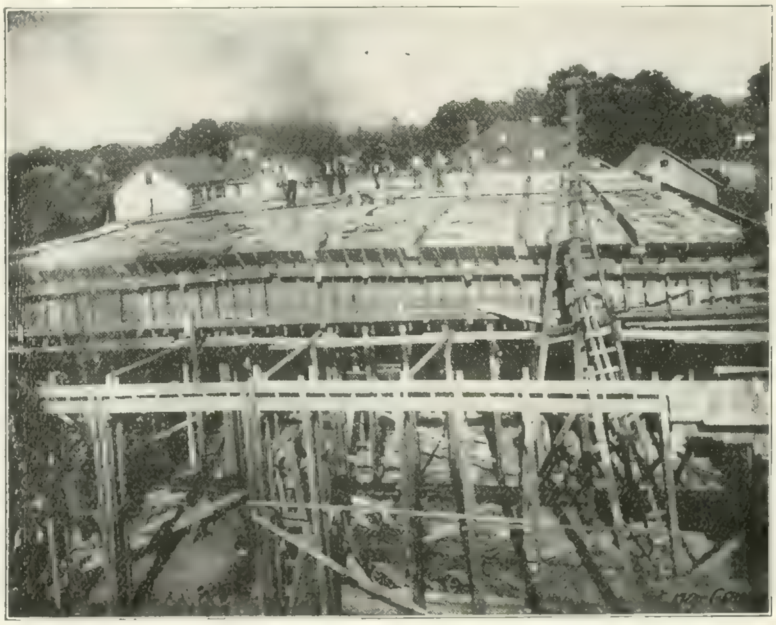


Fig. 2—General View of Roof Forms and Supporting Staging.

this method the reinforcing rods were held exactly in position.

These girders, and the roof-slabs as well, were made of concrete unusually rich in cement. Careful selection was made of all the materials. The proportions were 1 part Atlas Portland cement, 1½ parts sand and 3 parts crushed trap rock. Fig. 1 shows part of the roof and girder forms, as well as some of the reinforcing rods.

In erecting the garage the rear part was built first, and, as the panels for the roof were the same size as in the main part of the building, the same forms served for all parts. The front of the building was erected next, and finally the main part between the front and the rear.

The concrete columns were cast up to the fillet in one day. Then the top of the columns, the fillet and each entire 75 ft. girder was cast in another working day.

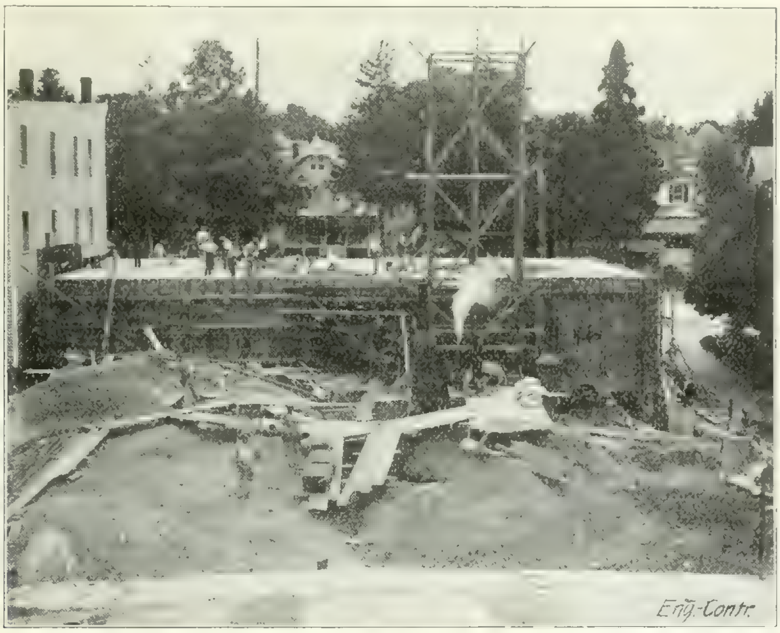


Fig. 3.—View Showing Mixing Plant and Concrete Hoist.

A fairly wet concrete was used, and the tamping was done with a tamper made of 2x4 in. scantling.

The forms were of 1-in. and 2-in. boards with 2x4-in. battens, and the props were of 4x6-in. sticks. Very few nails were used where they would interfere with easy removal of the forms. The forms on the sides of the large girders were stripped two weeks after pouring the concrete, but the bottom forms and props were left in place for six weeks.

Concrete was mixed with a Ransome mixer. The raw materials and the mixed concrete were conveyed in Ransome two-wheeled push carts. These carts proved superior to ordinary wheelbarrows, not only because of the larger loads conveyed, but because the materials could be accurately measured in the carts.

The specifications provided that the cement should be delivered "either in strong canvas bags or in strong barrels lined with paper. A barrel of cement weighs 376 lbs. net. Four bags of cement comprise a barrel, each bag of cement weighing 94 lbs." The Atlas cement was delivered in bags and emptied directly into the mixer. A rich mixture of concrete was used throughout. Even in the footings and columns the mixture was 1 part cement, 2 parts sand and 4 parts stone, while the girders were made even richer, as above stated.

The engineers who designed this garage were J. G. Ellendt & Co., of New York, Mr. C. E. Turrell having direct charge. The contractor was Mr. Hans Hilton, of White Plains, N. Y., who designed the forms and skillfully executed the work as called for in the specifications and plans. Indicative of the excellence of the design and execution of the work, is the fact that when the props were removed from the 75 ft. girders their deflection was so small as to be almost infinitesimal. We are informed that the deflection was only one-hundredth part of an inch.

Additions are now being made to the water supply system of Rio de Janeiro, Brazil, which will involve the expenditure of $9,000,000, and will bring an additional supply of 204,000,000 liters of water per day. The present supply is 146,000,000 liters from 11 stations.

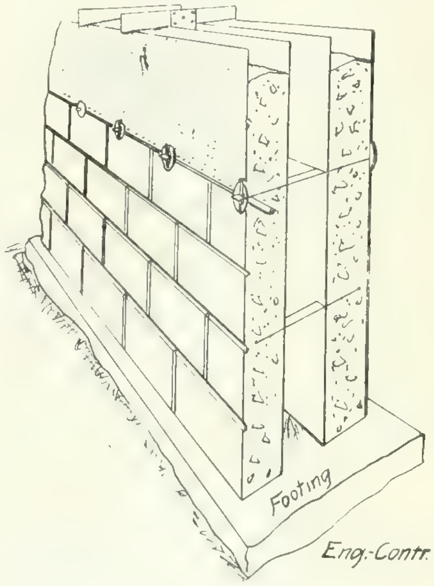
The grand total of excavation during April on the Isthmian Canal was 3,296,096 cu. yds. This was 184,174 cu. yds. less than the grand total in March.

The first electric street-car line in Warsaw, Russia, was placed in operation in April. The line has 180 cars.

A New Wall Form for Concrete Buildings.

We illustrate herewith a new style of forms invented for concrete work. The main idea in view was to make a hollow wall, while at the same time the wall would be monolith, instead of being made of blocks.

The forms themselves are made of steel, in lengths as long as 5 ft. Holes 3/32 of an inch are punched in the sheets, but the galvanizing nearly fills them. These holes allow the air to escape from the forms when concrete is being placed, but it is stated they are too small to let the cement and water run out. If the form sticks to the concrete, a brush dipped in water and rubbed over the outside will soon soften up the surface so that the form can be easily removed. Beading, moulding or anything to be placed in the face of the concrete can be wired to the forms by the aid of these holes.



Steel Wall Form.

To build a hollow wall four sets of forms are used. These are tied together by metal ties 1/16 in. in thickness and 1¼ in. wide. A wire nail goes through holes in the ties and holds the metal form in place. If a solid wall is to be built the inside forms are not used.

A patented paste is also used to put a finish on the concrete. By means of this paste put on the forms, gravel tiles or other material can be pasted to the forms and will stay in place until the concrete has been mixed and tamped. In this way the outside of a wall can be given a pebble finish, while the inside can be covered with tiles. If the form sticks to the finished surface the paste can be dissolved by water applied to the outside of the form.

These forms, ties and the paste are the invention of Wm. D. Ham, and are being placed on the market by the Monolithic Hollow Wall Co., of New York.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Electric-Air Drill.[*]

BY WILLIAM L. SAUNDERS[†]

The Electric-Air drill has been exhaustively tested in the field, under varied and arduous conditions and upon the hardest rocks. It is now fairly in the field; its merits and performances are matters of unimpeachable record, and its place among established competitors can be definitely determined.

As a representative of the Ingersoll-Rand Co., as well as a member of the Institute, I may be permitted to add that my company, being largely interested in the manufacture of air-compressors and machinery driven by compressed air, has no desire to injure its own business by claiming for this new machine that it should immediately supersede all existing applications of pneumatic transmission of power for drilling. On the other hand, if we had not satisfied ourselves that it has proved itself the best for given conditions, the company would not have risked its reputation by introducing it, and I, as a member of the Institute, would not have written this paper.

This drill is correctly designated; it is not an electric drill, but more completely an air-drill than any other in existence, because it can be driven by air only and not, like other air-drills, by steam also. Yet, while it is thus distinctly air-operated, the power-transmission is electric, and the sole connection of the drill with the power-house is made by the electric wire, air-compressors and pipe-lines being entirely superseded.

Fig. 1 gives a general idea of the apparatus. It shows a rock-drill, resembling at first glance, the familiar air or steam-driven drill, mounted in the usual way, and doing the same kind of work. Very near the drill, and connected to it by two short lengths of hose, is a small air-compressor, or, more properly, a pulsator, mounted upon a little truck. This constitutes the entire apparatus of a single drill. Each drill is accompanied by its individual pulsator, and each pulsator is connected to the line of wire from the power-house.

The usual drill-shell is employed, and may be mounted upon tripod, bar or column, according to the work. The drill-cylinder, fitted to slide in the shell, is moved forward or backward by the feed-screw. The cylinder is as simple as can be imagined; a straight bore, having at each end a large opening, and a boss to which the hose is attached. The piston also is plain, much shortened in the body, with a large piston-rod, which has a long bearing in a sleeve-elongation of the cylinder.

Upon the truck is mounted an electric motor, geared to a horizontal shaft, with cranks on each end, which drive two single-acting trunk-pistons making alternate strokes in vertical air-cylinders. One of these air-cylinders is connected by the hose to one end of the drill-cylinder and the other end of the drill-cylinder is connected by the other hose to the other air-cylinder. The air, therefore, in either air-cylinder, in its hose and in the end of the drill-cylinder to which it is connected, remains there constantly, playing back and forth through the hose according to the movements of the parts, being never discharged, and only replenished from time to time to make up for leakage. The propriety of calling the apparatus a pulsator instead of a compressor is evident.

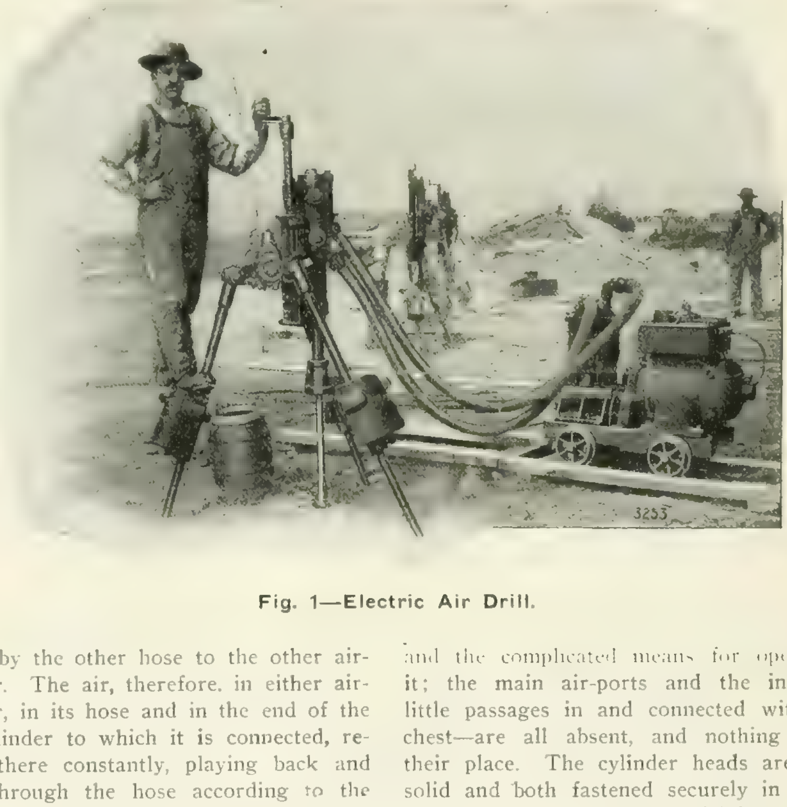


Fig. 1—Electric Air Drill.

The essential details of the cycle of operation will be easily understood. We may assume, to begin with, that the entire system is filled with air at a pressure of 30 or 35 lbs. This pressure being alike upon both sides of the drill-piston, it will have no tendency to move in either direction. If, now, the motor, instead of being at rest, is assumed to be in motion, one pulsator-piston will be rising in its cylinder and the other piston will be descending in its cylinder; and, as a consequence, the pressure upon one side of the drill-piston will be increased and the pressure upon the other side will be proportionately reduced, this difference of pressure causing the drill-piston to move and make its stroke. Just before the end of this stroke, the movement of the pulsator-pistons is reversed, and the preponderance of pressure is transferred to the other side of the piston, causing a stroke in the other direction—and so on continuously. The drill thus makes a double stroke, or at least receives a double impulse, for each revolution of the pulsator crank-shaft.

Having thus sketched the general principle of operation, I will proceed to discuss some of the details. The drill-cylinder, shown in Fig 2, while generally similar to that of the air or steam-drill, is in many respects quite different; and especially is it remarkable for its simplicity. The usual operating-valve-chest; the valve and the complicated means for operating it; the main air-ports and the intricate little passages in and connected with the chest—are all absent, and nothing takes their place. The cylinder heads are both solid and both fastened securely in place. The split front head, the yielding fastenings for both heads, the buffers, the springs, the side rods, etc., of other drills have all been banished. The cylinder is absolutely plain, with direct openings into the interior, and a boss at each end to which the hose is attached.

The piston also has been simplified. The device for securing rotation is necessarily retained; but the enlargement at the end of the piston rod, which constituted the chuck and necessitated the split front head, has been discarded. The piston rod is much enlarged throughout, and a simple but effective self tightening chuck is slipped upon the end of it.

---

[*] Abstracted from a paper read at Toronto, Canada, in July, 1907, before the American Institute of Mining Engineers.

[†] New York, N. Y.

The compressor or pulsator cylinders are likewise simple. There are no valves for either inlet or discharge, and there is neither jacketing nor the slightest need of it. The heating of the air by the compression stroke is compensated by the cooling which attends the re-expansion of the same air, so that it does not become increasingly hot and heat the parts of the machine with which it comes in contact.

While this apparatus as a whole may appear complicated at first glance, it is really a great advance in simplification. The parts which it eliminates are exactly those which have always been most troublesome and expensive to maintain, and both the drill and the compressor or pulsator are the simplest ever built.

In the foregoing description of the principle of operation I assumed a mean air pressure of about 30 lbs. in the apparatus. It may be asked how this pressure is secured and maintained. When the pulsator is in operation, the air pressure in the cylinders alternately rises above and falls considerably below the mean. At a certain point, indeed, it is below that of the atmosphere; and at this point a little valve is provided, which admits more or less air, until a sufficiency has been provided. At the beginning of operation the influx of air is rapid, so that no time is lost in getting sufficient pressure to begin with. The admission of air and also the apportionment of relative volumes thereof to the two ends of the drill cylinder are easily adjusted by the operator.

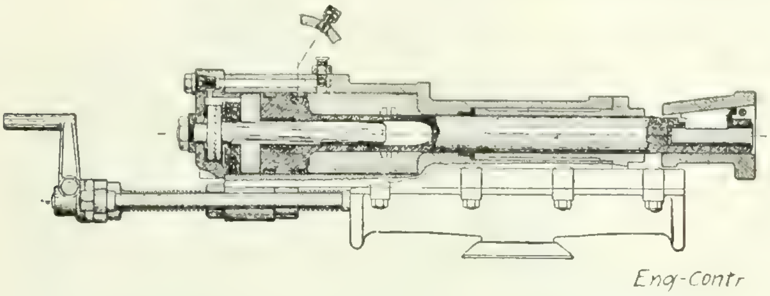


Fig. 2—Sketch of Drill Cylinder of Electric Air Drill.

The electric-air drill is not troubled by the freezing up or choking of the exhaust, because there is no exhaust. Moreover, the air does not accumulate moisture, and the temperature does not fall to the freezing point. Again, air becomes and remains a constant vehicle for the conveyance and distribution of the lubricant. A certain amount of oil being contributed to the system at regular intervals, it would be more difficult to prevent than to insure its reaching every working part.

The length of hose employed seems to be limited to about 8 ft. on each side. The hose may be attached to either side of the drill, but each always to its own end of the cylinder. This length of hose gives all necessary liberty for the location of the pulsator truck near the drill. The truck (of steel, with flanged wheels) is usually made for the standard 18-in. mine track, but may be made for any other gauge Special care in leveling is not necessary, since the pulsator will work at any angle at which the truck can stand.

Either a direct or an alternating current motor may be employed, the latter being preferred because it is a smaller, lighter, mechanically simpler, hardier machine, and more nearly "fool proof." Four different speeds may be obtained with the direct current and two from the alternating current motor—in the latter case full speed for steady running and a considerably lower speed for starting a hole or working through bad ground, with immediate transition from the one speed to the other, as required. The controller is on the top of the motor and the operator at the drill can start, speed or stop the motor by simply pulling a cord, this being the only connection. The electrical connection ends at the motor, both the hose and the cord insulate the drill and the operator is never exposed to the current.

The 5-C electric-air drill may be regarded as the full equivalent of the 3.25-in. standard air drill of any make; of its comparative efficiency something will be said later. The power requirement for this drill is from 18 to 20 amperes at 220 volts, or from 9 to 10 amperes at 440 volts—the electrical equivalent of about 5 h.p. The system being a closed circuit, this is independent of conditions of altitude, which make so much difference with the work of the air compressor which supplies the ordinary air drill.

The 4-C electric-air drill uses a 3-h.p. motor, and is a much lighter drill throughout, equivalent to a 2.75-in. standard air drill. Table I gives particulars of size, weight, etc., of both of these drills

The electric-air drill strikes a blow normally so much harder than that of the air drill of the same capacity, that it has been found advisable in many cases in "dressing" the steel bits to make them blunter or thicker, in order to avoid breakage. The practical force of the drill had not been computed beforehand, but was demonstrated in extensive practice and experiment, and the clear and sufficient explanation came later.

The drill piston, when running at full speed, and making a stroke for each rotation of the pulsator crank shaft, does not strike either head. The hole by which the air enters the cylinder from the hose is located, not at the extreme end, or close to the head, of the cylinder, but a certain distance away, so that when the piston approaches the head a portion of inclosed air acts as a cushion, which first checks the piston and then shoots it back. The piston thus starts upon its working stroke impelled by a certain amount of force, which, we may say, has been saved over from the preceding stroke to be utilized for this. The piston after being thus started is driven forward by an air pressure which increases as it advances, the pulsator piston being in the attitude of chasing and gaining upon the drill piston for a considerable portion of the stroke, while in the case of the ordinary drill piston, driven by a constant flow of air from which it runs away, the pressure must constantly diminish as the piston speed is accelerated. In the same way by the action of the other pulsator piston the opposing pressure upon the advancing side of the drill piston is a diminishing pressure instead of the constant atmospheric resistance, and these combined cause a greater unbalanced difference of pressures upon the opposite sides of the drill, a more rapid acceleration of the piston movement and a consequent higher velocity and force at the moment of impact of the steel upon the rock.

TABLE I.—Dimensions, Weights, Etc., of Temple-Ingersoll Electric-Air Drills.

	5-C.	4-C.
Diameter of drill-cylinder..	5⅝ in.	4.75 in.
Length of stroke	8 in.	7 in.
Length of drill end of crank to end of piston..	45 in.	42 in.
Depth of hole drilled without change of bit	24 in.	20 in
Depth of vertical holes machine will drill easily	16 ft.	8 ft.
Diameter of holes drilled from	1.75 to 2.75	1 to 1.5 in.
Strokes per minute	425	460
Horse power (at motor)..	5	3
WEIGHTS.	Lb.	Lb.
Drill (unmounted, with wrenches and fittings)	300	192
Pulsator complete with direct-current motor, mounted on truck...	883	585
Pulsator alone	271	160
Truck	102	100
Motor	400	275
Motor without armature	330	216
Armature alone	82	59
Controller, switch and rheostat....	72	50
Entire equipment ready for shipment, including drill, pulsator, direct-current motor, fittings, wrenches and extra parts, but no mountings, steels or blacksmith tools	1,680	902
Pulsator complete with 30- or 60-cycle alternating-current motor mounted on truck	630	360
Pulsator alone	271	160
Truck	102	100
Motor	202	137
Motor alone	46	34
Controller-switch with base.......	45	45
Truck cross-bars for motor	15	15
Entire equipment ready for shipment, including drill, pulsator, 30- or 60-cycle alternating-current motor, fittings, wrenches, and extra parts, but no mountings, steels or blacksmith tools..	1,080	680
Tripod with weights	540	430

—Note.—Weight of column and shaft-bar mountings will vary with their length and diameter.

Perhaps the most gratifying and also surprising revelation of all in connection with the electric-air drill is the now indisputable fact that it takes only from one-third to one-fourth of the power, at the power house, to drive it to do the same work. This is accounted for by the fact that the same air is used over and over, and that all of its elastic force is availed of in both directions instead of exhausting the charge for each stroke at full pressure. There are also no large clearance spaces to fill anew at each stroke, as these spaces are never emptied.

A valuable feature of the electric-air drill is the ability to yank the bit free if stuck in a hole and immediately continue its work. When the bit of the ordinary air or steam drill sticks in the hole the drill stops and the drill runner must free the bit as best he can. Ordinarily the feed is run up and down, the drill is hammered and things are coaxed in various ways until the bit is free. When the bit of the electric air drill sticks, the motor and the pulsator pistons do not stop. If the drill piston is making, say 400 strokes a minute, as soon as the bit becomes stuck the piston will receive per minute 400 alternate thrusts and pulls with full force, and nothing could be more effective for freeing the bit than these alternate thrusts and pulls. Often when the bit sticks and before the runner can get ready to do anything about it, the drill frees itself and is running again as if nothing had happened.

The coming of the electric-air drill suggests many possibilities and ominously means much to established interests. It necessarily suggests a revolution in methods and sometimes perhaps a superseding of the old plants throughout. In the working of the new drill the old central air compressor plants are absolutely worthless, but it is not easy to imagine any general abandonment of them. After all, the result may probably be that the new drill will not to any great extent drive out the old, but will make a new field of employment for itself, and in that way lead as usual to a considerable enlargement of the already extensive business which is behind it. As has been shown, the electric-air drill is far from an electric drill, but the ordinary electric current, now nearly everywhere available, can be used for operating it.

In planning new installations the electric-air drill is to be most seriously considered. The relative final cost of operating this or any other drill is, after all, the decisive question, due recognition, of course, being given to the peculiarities of each drill, favorable or otherwise, which are not computable, but which still have weight in determining the selection, "other things being equal."

When the electric-air drill is operated without its own generating plant, the current being taken from a large power company, some very low figures are already on record. At Idaho Springs, Colo., a mine shaft was put down 67 ft. in 24 shifts and the total power cost was $24 for the entire work.

In making rock excavations for building purposes in New York city and elsewhere, steam drills, having a temporary boiler installation, are frequently used. The electric-air drill not only avoids the expense of the boiler equipment but will do the work at a much lower cost, the current being supplied by one of the big electric power companies.

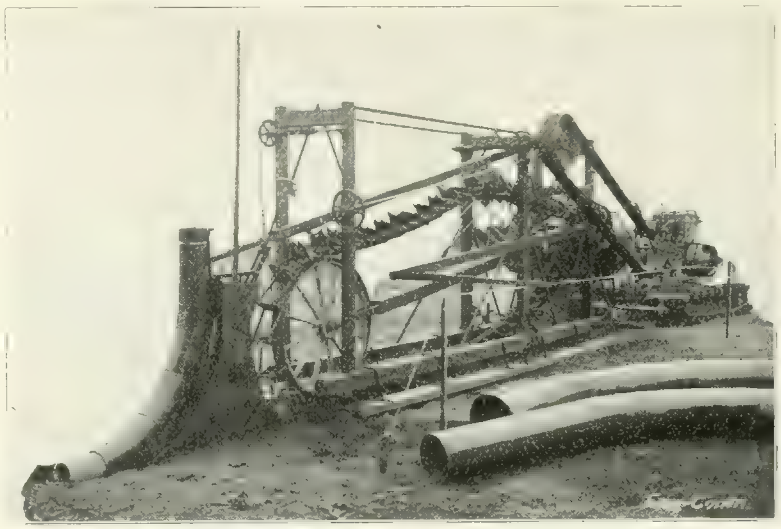
A Combination Ditching and Tile Laying Machine for Farm Drainage.

The accompanying illustration shows the main portions of a unique machine for farm drainage work that has been tested out with satisfactory results in several important pieces of actual work. The machine as will be observed, consists of two units; the excavator and tile laying mechanism and the propelling and operating mechanism. The relation of the two units is clearly shown by the illustration.

This machine is designed particularly for farm drainage work and for successful operation on soft ground. For the latter purpose the gasoline engine which propels and operates the ditcher proper is mounted on an endless traction having a broad bearing surface on the ground. Also, the ditcher proper is mounted on skids which by the means shown are made variable in height. By this means the ditchers will operate on sidling ground and excavate a perfectly vertical ditch. The traction and ditcher each weigh about 4,000 lbs., and when moved from one job to another are mounted on wheels and hauled by teams.

The excavating action of the ditcher is obvious from the illustration. The scraper buckets are self-cleaning and automatically discharge into a conveyor which deposits the spoil well to one side of the ditch. Just back of the excavating wheel is a shield which carries the chute into which the tile are put. This shield maintains the sides of the ditch and prevents caving onto or under the tile.

This machine is made in two styles by the St. Paul Ditcher and Carrier Co., St. Paul, Minn. The single wheel machine digs a ditch for and lays tile 4 to 12 ins. in diameter and 13 ft. deep. The double wheel machine digs a ditch for and lays tile from 12 to 24 ins. in diameter. The double wheel machine can be adapted for small sizes by simply removing one wheel, beam and chain. The speed of operation is as follows: Ten feet deep, 100 ft. an hour; 7 ft. deep, 140 ft. an hour; 4 ft. deep, 160 ft. an hour; 2 ft. deep, 200 ft. an hour.



View of Combination Ditching and Tile Laying Machine.

The German postal authorities and the city officials of Berlin have concluded negotiations for a scheme to connect the general postoffice in that city with the various branch offices by the construction of an underground railway, by means of which the more rapid distribution of the mail bags to and from the mail trains will be effected at a speed of about 25 miles an hour. The railway will be worked without a guard or driver, and the tunnel, which will be placed close beneath the road surface, is to be only 29 ins. in height by 71 ins. in width. Each truck or car is intended for the conveyance of a large-sized mail bag. The complete train will be composed of a dwarf electric locomotive and not more than 4 trucks. The locomotive will have a pair of axles, each furnished with a motor. The line will be double track throughout, constructed on a 16.13-in. gage. Over each track will be conductor rails. A trench will be provided between the two lines of rails, so that a man will be able to pass through the tunnel. The railway is to be operated by electricity.

At the beginning of last year there were 10,776 miles of railways in operation in Brazil.

In 1907 the 1,200 street and interurban railway companies operating in the United States carried nearly 8,000,000,000 passengers. These companies operated over an aggregate of 40,000 miles of track.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Municipal Asphalt Repair Plant of the Borough of Brooklyn, and Data on the Cost of Operating It.

The asphalt repair plant of the Borough of Brooklyn, N. Y., was placed in operation on June 13, 1907, and the data which follow cover the period to Dec. 31, 1907. The plant was constructed for the city by the Warren Asphalt Paving Co. and has been operated by the Bureau of Highways, Mr. Jno. S. Sheridan, Chief Engineer, to whom we are indebted for the information in this article.

The plant buildings are built of steel, and all wall coverings are covered with No. 26 galvanized corrugated iron; all roofs are covered with the same material of No. 22 gauge. The main portion of the building is three stories high, the second story containing the mixing and weighing apparatus. The floors of both the second and third stories are constructed of reinforced concrete to render them fire proof. The third floor is arranged so as to give easy access to all of the bins and elevator driving mechanism. The tank room is two stories high, the upper or charging floor being covered with reinforced concrete. The engine room is one story high. Ventilation on the second floor of the tank room and mixing platform is secured by hanging hinged shutters, which may be closed to keep out rain. The third story of the main building has galvanized iron louvers in addition to the windows to furnish light and ventilation.

The equipment includes three self-contained rotary dryers manufactured by the Warren Asphalt Paving Co., two of which are used for drying and heating sand and one for binder stone. The revolving cylinders of these dryers are 40 in. in diameter and 19 ft. 6 in. long and are made of ⅜-in. steel plate, with vanes running longitudinally therein, to lift the material being dried to the top of the shell and drop same through gases running through the inside of them. Each of these driers has a grate surface of at least 29 sq. ft. and draft is supplied to the double driers by a 50 in. steel plate exhauster and to the single driers by a 40 in. steel plate exhauster, each exhaust fan discharging into a cyclone dust collector. The double dryers are fed by two elevators which feed directly into them without the use of a worm conveyor, while the single driers have a single raw material elevator. Each drier set is driven independently so that either drying set may be used at the same time or independently. Each drying set discharges into an elevator fitted with 10 in. by 6 in. malleable iron buckets, on a malleable iron elevator chain which conveys the material to the respective bins.

The binder stone and hot sand storage bins are made of steel and have a capacity when level full of 9 cu. yds. The hot stone sand bin is fitted with a rotary screen 24 in. in diameter and has an effective screening length of 3 ft. This screen is so arranged that in case it is desired to mix binder from this bin the screen may be readily moved out of the way to allow the binder stone to drop directly into the bin. Each of these bins are enclosed in a suitable covering to obviate as far as possible the loss of heat from open bins and to reduce to a minimum the dust which always arises from screening hot dried material. A suitable tailing spout is provided to carry the rejections away from the sand screen.

The material from each of the bins is drawn by gravity through an orifice in the bottom of them by means of a swinging gate into the weighing box, having a capacity when full of at least 11 cu. ft. This weighing box rests on platform scales which allow an accurate weighing of each batch of material, and each scale is fitted with a double beam so that the amount of dust used in each batch of topping may be accurately weighed also. A dust bin is provided, capable of discharging into the sand weighing box. The dust bin is filled by means of an elevator reaching to the ground floor with a suitable boot into which the dust may be emptied to the elevator. The weighing boxes discharge into mixers, capable of mixing thoroughly and economically batches of at least 9 cu. ft. of sand and 10½. ft. of binder. Each mixer is provided with a clutch which may be thrown out quickly in case of accident to the machine. These mixers discharge by gravity into teams which drive directly underneath and the driveways have sufficient clearance so that teams will not interfere with each other when driving under their respective mixers.

For the preparation of asphalt cement three mixing agitating tanks are provided, having a capacity of 1,500 gallons each. These tanks are so arranged that the agitation of either one or all may be operated separately or together. These tanks are enclosed tanks, capable of withstanding 15 lbs. of air pressure. The asphalt is fed into asphalt buckets by stand pipes running to the bottom of each tank on each end and rising above the floor to a sufficient height to discharge properly in the asphalt weighing buckets. The tanks are so arranged that either of the three tanks or all of them may be used for asphalt cement to supply either one or both mixers.

Asphalt buckets are suspended on a suitable carrier running on overhead trackways leading from the asphalt tanks to each of the mixers and each bucket is supplied with scales which weigh the bucket full and empty.

A barrel elevator is used to hoist the asphalt barrels from the ground floor to the charging floor. This elevator is driven from the agitating tank engine, so that the tanks may be charged at night without running the whole plant. Steam is supplied by a 60 h. p. water tube boiler, manufactured by the Babcock & Wilcox Co. Power to the main portion of the plant is supplied by a 10 in. x 12 in. automatic cut-off center crank engine, manufactured by the Erie Engine Works, Erie, Pa. The engine is capable of producing 56 h. p. when running at 253 revolutions per minute, with 50 lbs. mean effective pressure. Since it is desirable to have the power for the agitating tanks independent from the main engine so that the tanks may be charged and agitated without running the rest of the plant power is supplied for this purpose and to the barrel elevator by a 5 in. x 5 in. vertical automatic cut-off engine, manufactured by the Sturdevant Blower Works, Hyde Park, Mass., capable of producing 9 h. p. when running 450 revolutions per minute.

Compressed air for use in forcing the asphalt out of the tanks and for other purposes is furnished by a 6 in. x 8 in. x 12 in. Knowles direct acting air compressor, capable of supplying 50 cu. ft. of free air per minute at 15 lbs. pressure.

Power from the engine to the main shaft is carried by a 16 in. 6-ply rubber belt and the distributing arrangements for power used throughout the plant are such that either the binder or topping portion of the plant may be thrown out of gear without interfering with the operation of the rest of the plant. The dust elevator is provided with a clutch so that it may only run when it is needed.

The following cost data cover the period from June 13, 1907, when the plant was placed in operation, to Dec. 31, 1907:

COST OF PLANT.

Contract	$22,485.00
Engine and boiler foundations, piles, etc.	509.54
Office and sheds	712.00
Fire ext'ing	150.00
Oil tank	365.00
Extra parts—machinery	411.76
Office furniture and equipment	174.28
Electrical work, wiring, lights, annunciators	58.80
Four asphalt rollers	6,156.00
Twelve asphalt trucks	4,920.00
Tools and gang equipment	2,000.45
Miscellaneous	337.35
Total	$38,280.18

FIXED CHARGES.

Interest on payments on above at 5%	$807.10
Depreciation on plant at 10% (6½ months) on $37,892.08	2,052.49

Rent of plant grounds, $1,440 per year, 7 months	840.00
Total	$3,789.59

The total product of the plant was 8,475 boxes of wearing surface and binder. These boxes are 9 cu. ft. at the plant. During transportation from the plant to the job there is a consolidation of the wearing surface material in the truck. This has been found to be on an average load and distance a trifle less than 3 per cent of the original bulk. On binder this consolidation is not appreciable. The 9 ft. box of wearing surface mixture as delivered on the job is therefore taken to contain 8.75 cu. ft. The product of the plant consisted of 6,951 boxes of wearing surface mixture, equivalent to 60,821 cu. ft., and 1,524 boxes of binder, equivalent to 13,716 cu. ft. The total product was therefore 74,537 cu. ft.

The expenditures for supervision, labor, materials and supplies on the above production was:

Superintendent asphalt repairs	$1,363.13
Plant labor (including foremen)	12,188.34
Street labor (including foremen)	19,970.33
Trucking, team and driver, at $6 per day	7,915.25
Cord wood (68 cords)	771.00
Dumping privileges	140.05
Oil	166.34
Waste	92.08
Rosendale cement	150.00
Canvas covers	35.45
Miscellaneous supplies	63.15
Coal for rollers, 47.6 tons, at $5.50	261.80
Coal for plant, 315 tons, at $3.98	1,253.70
Repairs—tools	206.23
Repairs plant	769.05
Flux (96,820 lbs.), 12,102.5 gal, at 7⅜ cts.	892.52
Asphalt, 40 tons at $24.77 per ton, 295 tons at $24.80 per ton	8,306.80
Stone dust, 296.2 tons at $3.50 ton.	764.00
Binder stone, 586.4 cu. yds. at $1.45 cu. yd.	850.32
Asphalt sand, 2,871 cu. yds. at $.75 (less credit on 100 yds. at $.75 of grit to Wallabout)	2,078.25
Total	$58,247.00
Fixed charges	3,789.59
Grand total	$62,037.28

The material used in the 6,951 boxes of wearing surfaces was as follows:

2,771 cu. yds. sand at $.75 cu. yd.	$2,078.25
592,416 lbs. dust at $3.50 per ton	764.00
91,274 lbs. (11,409 gals.) flux at $.07⅜ per gal.	841.41
631,630 lbs. asphalt at $24.80 per ton	7,832.21
Total	$11,515.87
Cost of materials per box	$1.657

The sand measured in scow (as paid for) allows for waste in yard, tailings and loss of weight on moisture. The actual quantity of heated dry sand as weighed in on mixing platform was 2,136 cu. yds. The weights of stone, asphalt flux and dust are as weighed in.

The materials used in the 1,524 boxes of binder were as follows:

586.4 cu. yds. stone at $1.45 cu yd.	$850.32
5,546 lbs. (693 gals.) flux at $.07⅜ per gal.	51.11
38,370 lbs. asphalt at $24.80 per ton.	475.79
Total	$1,377.22
Cost of material per box	$0.904

All prices are for the material delivered in yard at plant.

The cost per box of supervision, fixed charges, supplies, coal and repairs was $1.070, or $0.1223 per cubic foot of asphalt wearing surface and $0.1190 per cubic foot of binder.

The cost per box for labor and trucking was $4.727, or $0.5400 per cubic foot of asphalt wearing surface and $0.5252 per cubic foot of binder. The cost complete for wearing surface was $7.454 per box; for the binder the cost complete was $6.701.

SUMMARY OF COSTS.

	Wearing Surface.		Binder.	
	Per Box.	Per Cu. Ft.	Per Box.	Per Cu. Ft.
Materials	$1.657	$.1894	$0.904	$.1004
Supervis., fixed, charges, etc.	1.070	.1223	1.070	.1190
Labor and trucking	4.727	.5402	4.727	.5252
Total	$7.454	$0.8519	$6.701	$0.7446

These costs are on a basis of 8.75 cu. ft. per box as delivered on the street, equivalent to $.85 per cubic foot for wearing surface and for binder, 9 ft. box, $.74½ per cubic foot.

The accompanying table gives an analysis of the costs:

	Wearing Surface and Binder Per box	Wearing Surface Per cu. ft on street	Binder Per cu. ft. on street
General Costs			
Superintendence	$0.1608	$0.0184	$0.0179
Plant Labor	1.4380	0.1645	0.1598
Street Labor	2.3560	0.2695	0.2618
Trucking	0.9338	0.1067	0.1037
Wood, Fire Wagon Fuel.	0.0909	0.0103	0.0101
Coal, Plant	0.1478	0.0169	0.0164
Coal, Rollers	0.0307	0.0034	0.0034
Dump Privileges	0.0176	0.0020	0.0020
Rent	0.0990	0.0112	0.0110
Interest	0.1058	0.0120	0.0117
Depreciation	0.2420	0.0277	0.0269
Repairs to tools	0.0243	0.0027	0.0027
Repairs to plant	0.0906	0.0103	0.0102
Miscel. supplies	0.0597	0.0068	0.0066
Totals	$5.7970	$0.6625	$0.6442

	Binder Per box.	Wearing Surface Per box.	Wearing Surface Per cu. ft on street	Binder Per cu. ft. on street.
Materials.				
Flux	$0.0340	$0.1210	$0.0139	$0.0037
Asphalt	0.3120	1.1270	0.1287	0.0347
Sand	.....	0.2990	0.0342	....
Dust	.....	0.1100	0.0126	....
Stone	0.5580	.....	....	0.620
Totals	$0.9040	$1.6570	$0.1894	$0.1004
General Costs.	5.797	5.797	.6625	.6442
Grand Totals.	$6.7010	$7.4540	$0.8519	$0.7446

The wages paid for eight hours per day were: Plant foreman, $6.00; foremen, $4.00; rakers, $2.50; tampers, $2.50; smoothers, $2.00; laborers, $2.00; trucks, $6.00.

The charge for trucking, $7,915.25, is total truck time at $6 per day, and includes all delays at plant and on street and also trucking old asphalt and debris to dump. The average haul was 4.14 miles from plant; 129 loads traveled 534.4 miles—plant to job—to 25 different locations in all sections of the borough. Observation on 35 loads for rate of travel for loaded trucks, 72 cu. ft. wearing surface on load, gave 2.15 miles per hour. The plant has had free dump on a considerable quantity of old asphalt. The total number of working days was 134 out of 202. The cost per box for labor (plant and street) has varied considerably, depending principally on the output.

The accompanying table shows the monthly costs, the total product and monthly box cost:

BROOKLYN ASPHALT REPAIR PLANT—MONTHLY COSTS, TOTAL PRODUCT AND MONTHLY BOX COST.

Month.	Plant Labor.	Street Labor.	Trucking.	Product. Boxes.	Labor Cost. Per Box.	% Street.	% Plant.	% Trucking.
June	$ 1,004.37	$ 803.75	$ 367.25	331	$6.57	37	46	17
July	1,114.00	3,129.00	1,066.00	1,201	4.42	59	21	20
August	2,032.75	3,619.47	1,359.00	1,330	5.27	52	29	19
September.	2,056.87	2,930.49	963.00	1,415	4.20	49	34	17
October	2,556.50	3,655.98	1,506.00	1,909	4.04	47	33	20
November	1,470.87	2,998.89	1,537.50	1,305	4.60	50	24	26
December	1,952.98	2,832.75	1,117.50	984	6.00	46	33	19
Total	$12,188.34	$19,970.33	$7,915.25	8,475	*$4.73	*49.6	*30.4	*19.6

*Average.

The establishment in Ireland of a new electric supply generated by peat gas (the first of its kind in Great Britain), is proposed by the Dublin and Central Ireland Electric Power Co. The company proposes to supply electricity to portions of counties Dublin, Kildare, Queens and Kings, and has arranged to purchase 500 acres of peat bog in the district.

A scheme has been submitted to the Danish government for a canal across the northern part of the peninsula of Jutland, making large use of the Liim Fiord, which passes into the peninsula from the Kattegat for a considerable distance inland. The canal, as planned, would have a depth of 26.25 ft.

The Austrian government is considering electrifying 2,000 miles of trunk line railway system in that country.

Methods and Costs; Some Old; Some New.

Cost of Operating a Suction Gas Producer Plant.—The following data are taken from a paper by Prof. H. B. MacFarland, read before the Western Society of Engineers. The data were supplied by Mr. I. J. Babcock, Superintendent of the A. B. Dick Co.'s Plant, 161 W. Jackson Boulevard, Chicago. The power plant itself is unique in its installation, its method of operation and its efficient output. The installation consists of two units. The principal unit consists of a 100 h. p. gas producer, a 100 h. p. twin gas engine, direct connected to a 65 kw., 230 volt D. C. generator and a 200 ampere hour storage battery, 112 cells in a main battery and 26 end cells, used for both light and power purposes. The secondary unit consists of a 75 h. p. gas producer and a 50 h. p. single gas engine, direct connected to a 35 kw., 230 volt, D. C. generator. The piping between the producers and engines is such that either engine can be operated from either producer. The small producer will make gas for the large engine for a period of six hours without showing signs of being overcrowded. The smaller engine can be operated when a small amount of power is needed. In case the plant is not in operation, light and power can be obtained for a period of time from the storage battery. In case of exceptionally heavy loads the two engines can be run in parallel to give 150 brake h. p. The producers and engines were built and installed by the Minneapolis Steel & Machinery Co. The plant has been installed for nearly two years. Besides the regular generator, vaporizer, superheater and scrubber that go with every producer, there are auxiliary pieces of apparatus. The blower for starting up the generator is driven either by a 3 h. p. gas engine or by a 3 h. p. motor. There is a one-eighth h. p. motor on the night stack which is used when starting up the plant as the stack is very high, extending to the top of the building. The manometer board has connections so that one can quickly test out the air resistance either through the generator, wet or dry scrubber, in case the plant does not operate properly. The generator is charged at short intervals during the day, ranging from one-half to two hours, depending upon the load. The charge is always 70 lbs. of coal. The attendant judges by the condition of the top of the fire when the charge should be put into the generator. The fire is always poked in the morning but is never pulled down so that the red coals show on the grate. The buckwheat anthracite coal is very completely burned, giving a high grate efficiency. The best results are obtained when the temperature of the saturated air going to the base of the generator is between 140 and 160 deg. F. At this temperature the air carries the right amount of moisture so that the producer gas does not contain too great a per cent of hydrogen. During the year ending Dec. 31, 1907, a total of 125,437 kilowatt hours service was obtained from the plant. The total operating expenses for the year and cost of operation per kilowatt hour were as follows:

	Total.	Per Kilowatt Hours Cent.
Coal	$550.36	0.439
Oil	54.24	.043
Waste	11.52	.009
Water	168.00	.134
Gas	33.32	.027
Attendance	422.94	.337
Repairs	224.50	.179
Insurance	93.42	.075
Lamp renewals	28.16	.022
Totals	$1,586.46	1.260

One man looks after the plant, heating boilers, sprinkler system, and cleans and oils all the motors so that only half of his time is charged to the producer plant. While the plant is operated at only 52 per cent of its rated capacity, yet as compared with the Edison service that was used for five years it shows a profit of 10 per cent after charging off 10 per cent for depreciation.

Protection of Meadow Roads from High Tides.—Several of the State aid highways in Cape May County, New Jersey, are constructed across swamp or marsh lands in close proximity to the sea coast. The pavement on these roads consists of shells, covered with 4 ins. of compacted gravel. Owing to the infrequency of severe storm tides, and the expense it would involve, the roads are not elevated to a height above the rise of storm tides, but are constructed to withstand being submerged and the severe washing caused thereby. One of the most important features in the construction of these roads to protect against the washings is the use of a curb or guard plank placed horizontally along on each side of the roadway and securely fastened to the piling forming a part of the road construction. These planks are placed 1 in. above the gutter line to allow free drainage from rainfall. The top of the planks are level with the crown of the road, thus protecting the road from the wash, and at the same time, if the crown is flattened or moved either side by the action of the water, the guard planks hold the gravel moved and prevent it being washed entirely away. Then after the tide has fallen the gravel may be replaced by the use of the scraper. The efficiency of these guard planks was clearly demonstrated in a severe storm during the construction of the Sea Isle turnpike, for on such portions as the planks were not in place the crown was entirely washed away, while on portions where the guard planks were in place the roadway was intact.

Cement Storage House.—In constructing the Big Rapids dam near Big Rapids, Mich., the following plan was adopted for storing the cement. The cement was shipped in cloth bags in January and February, and hauled in the snow 1½ miles. It was stored in sheds 40x90 ft., with one-third pitch bottom roof covered with tar paper, in the usual manner of lumber camp construction. The floor consisted of two layers of 6-in. poles laid on the ground, the second layer being at right angles to the first. The poles were covered with about a foot of loose straw, on top of which was placed a single layer of tarred felt. The bags were then piled 5 ft. high on end. No cement was lost by caking. The only cement showing effects of dampness was that on top, which gathered some moisture from the air and caked in places about ½ in. thick. If tarred paper had been put over the tops of the sacks it is thought that this caking would probably not have occurred.

In France many of the state roads are bordered with shade trees planted not only for furnishing shade but in order to protect the roads from the effects of excessive drought and heat. Regarding this a recent consular report quotes F. Birot, formerly conductor of the Bureau of Bridges and Highways of France, as follows: "In countries where the climate is damp roadside trees are prejudicial to the maintenance of the highways, as they prevent the circulation of the air and the drying of the soil; in most of the southern French regions such plantations are, on the other hand, very useful in dry weather, as they maintain the roadbed in a state of freshness favorable to its conservation. In general, trees should be selected with high spreading branches, such as the poplar, the elm, the ash, and they should be planted generally upon the outer edge of the road-box and at distances of 32.80 ft. Each tree should be placed in a hole 3.28 ft. deep and 4.92 ft. square, and should be trimmed to a height of 8.20 ft. above the surface. The earth about newly planted trees should be loosened in March and November—in March only after the third year—and thereafter until their permanent growth appears assured; small trenches should be directed toward the foot of the tree, in order to secure the benefit of rains. Finally, the tree itself should be trimmed annually during the first ten years.

A bill was introduced in Congress on May 19 providing for the appointment by the President of a National Commission for the Conservation of Natural Resources of the U. S.

Method and Cost of Constructing a Telephone Line.*

The poles in most common use are white cedar and chestnut, although many other woods have been used; but the above have given very satisfactory service. Poles made of reinforced concrete are being used to a limited extent and those companies using them recommend them very highly. In the central west the white cedar is used almost exclusively, although some chestnuts have been tried and some western red cedars. The latter are famous for being very straight and sound, but they are usually very slim and are not much larger at the bottom than at the top. The western red cedar poles make a very stately looking line, but when obtainable the white cedar, with its larger bottom, is usually preferred. Northern white cedar poles are usually sold under the Northwestern Cedarmen's Association specifications, although most of the large buyers draw specifications somewhat more strict than those of the Cedarmen's Association.

Before setting, the poles should be shaved and carefully framed. That is, the top should be "roofed" by sawing off pieces at an angle of 45° to the side, leaving the top of the pole sharpened to an angle of 90°. A "roofed" pole sheds the water more effectively than if left flat, thus making the top less liable to decay. Gains or flat spots about ½ in. deep should be cut in the poles that are to carry cross arms at the points where the arms are to be fastened, thus forming a good bearing for them, and one hole large enough to take a ⅝ in. through bolt should be bored through the poles at each gain that is to be used at once. The roofs and gains should be painted with a good paint that will close all the pores and thus stop the entrance of water and prevent decay. The butt should then be treated with some preservative. The one used most is a substance called carbolinium, which has proven to be very valuable and in some cases actually doubled the life of the timber used. Since the labor of replacing poles is so high, it is very essential that the poles last as long as possible without having to be reset or replaced.

The poles should be set substantially, and to make a good job, the soil and weather conditions should be taken into account. In ordinary soil not subject to floods a good rule to follow is to set a 25-ft. pole, 5 ft. deep, and to dig the hole 6 in. deeper for each additional 5 ft. of length. Thus a 40-ft. pole would be set 6½ ft. deep, which is probably a trifle deeper than they are usually set. If the ground is moist or marshy or if otherwise unsatisfactory conditions are met, special settings must be provided. For instance, a barrel of sand is sometimes used at the bottom of the pole; or rocks, ties or timber are put in the bottom of the hole or a foundation of several inches of concrete is used or the pole is set entirely in concrete. Sometimes in street railway work, the butt is set in concrete to the depth of about 6 ins., then dirt filled in and tamped to within 6 ins. or a foot from the top, then this part filled in with concrete, so that the strain or the span wire will be taken up in the enlarged surface at the top and bottom of the pole, at which points the strain is the heaviest.

Great care should be exercised in the location of poles. In the building of a new plant as well as in construction work in an old one, the law regarding the location of poles should be referred to, in order that it will not be necessary at some later time to move the poles, which is an expensive operation. Poles located in streets and alleys should usually be set on lot lines in order that the residents of the neighborhood cannot complain that they interfere with driveways, barns, etc. In setting poles along streets and alleys which are not paved great care should be taken in their location, so that if paving is put down at a later time that it will not be necessary to move them. Here it might be stated that where two cables cross at right angles at intersections of streets, or of a street and alley, it is not good practice to locate a pole at the point where the intersection of the lines will be, for the reason that it runs a double chance of having to be moved if either street or alley is paved.

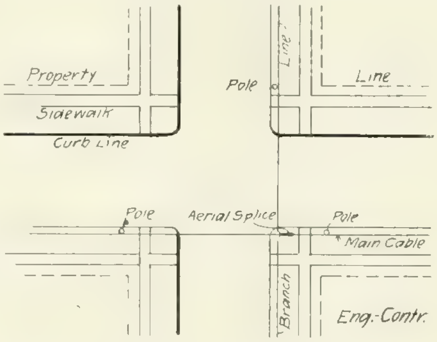


Fig. 1—Sketch Showing Method of Making Aerial Turn.

A very effectual way to overcome this trouble is by making what is known as an aerial turn as illustrated in Fig. 1, setting the four nearest poles back at such a distance from the intersection that there is little probability of their having to be moved. In case they should have to be moved at a later date, it could be accomplished much easier than if the messenger and cable had been fastened to a pole at the corner.

Fir cross arms have been used most generally, and have given very satisfactory service when not painted. It seems that filling the pores with paint causes the arms to rot inside, with the consequence that some day they break off while they are apparently in good order. This is a source of accidents to employes on account of the arms not showing their real condition.

Locust pins have given most general satisfaction for many years. Many other woods have been used, among them being oak, which is not satisfactory, and osage orange, which is very good. Iron pins are used by the telegraph companies, but have not come in general use on telephone lines.

The hardware used should be heavily galvanized to secure long and efficient service. This is especially true in damp climates. While galvanized hardware lasts much longer than plain, it is open to the objection that all the threaded parts must be cut first and galvanized afterwards. This necessitates the cutting of loose threads and making up the difference with a coat of spelter, which may come off later and leave a poor thread.

Anchors are very important. They should be used at every place where a branch leaves the main line or where there is an offset in the line and at every dead end. The material used for the "slugs" or dead men may be any one of several kinds. Those used most are wood, either logs, parts of poles, ties or other timber; these may be used plain or soaked in some preservative; treatment similar to that given pole butts. Since any of these wooden slugs will last but a comparatively short time under ordinary conditions, several patent metallic anchors have been put on the market in the last few years in an effort to get a cheaper and more durable anchor. Some of them are really meritorious and others have proven dismal failures, while almost any of them are of some service under the right conditions.

Considerable judgment must be displayed in choosing an anchor. Be sure that the size used is the smallest that will hold the load safely; but do not carry economy too far and get an anchor too small for the service required. By figuring the cost of material and labor of setting, it is an easy matter to choose the anchor giving the best result.

A new departure in anchors is the use of a reinforced concrete slab for the deadman, the idea being that the concrete slab is practically indestructible so that if the proper size is chosen it should last for a very long time without having to be replaced.

Concrete anchors have been used by the writer to hold medium loads at the end of messengers carrying cables of various sizes. The dimensions of the anchors used most were as shown in Fig. 2. The face was 18x18 ins. square; the reinforcing metal being heavy steel, woven wire fencing, laid double about 1 in. from the face of the anchor; then about 4 to 6 ins. of concrete was put behind the steel and the rod was put through the center of the slug.

---

*Condensed from a paper by L. E. Hurtz in "The Nebraska Blue Print," Vol. vii., 1908. Published by the Engineering Society of the University of Nebraska, Lincoln, Neb.

When the material cost is slightly higher, the advantages of the concrete anchor are considerable. It can have a square face, thus making it possible to use smaller holes than if a "slug" or tie had been used. Less tamping is required, because when the digging of the hole is nearly finished the bottom can be shaped into a mold, into which the concrete is poured; when hard, the anchor pulls squarely against a smooth surface of solid earth which is cut to the proper angle, so that all the tamping required is that necessary to keep the walls from caving in. When ordinary anchors are used the tamped loose dirt has to carry a part of the load.

The comparative cost of anchors is shown in the following table:

	Concrete Anchor	½ of Oak Tie.
Digging hole	$0.45	$0.60
Labor, making, tamping.....	.58	.60
Setting and material.........	.48	.35
Rod	.27	27
	$1.78	$1.82

It shows that the concrete anchors were made at a slightly lower cost than the old style and they certainly ought to last much longer.

When an anchor has to hold an unusually heavy strain, the area of the slug or deadman is often increased by "planking," that is, putting planks or timber in the hole in such a way that the anchor pulls against them, which serves to increase the anchor area to as great an extent as is desired. Anchors should be set as far back from the butt of the pole as the pole sticks out of the ground, that is, so that the guy pole wire pulls against the lead at an angle of about 45°. An anchor set within a few feet of the butt of the pole can hold but a very light load.

When locating an anchor, be sure that the anchor rod or guy wire will not interfere with anyone's driveways or barn door or with any other private property; a little care may avoid having to reset the anchor at a later date.

Side and head guys should be used at intervals on all long heavy lines, in order that if the line is struck by a heavy storm or part of it wrecked by a fire or other trouble, the entire line will not be bowled over like a lot of tenpins.

The wire or cable used to connect the anchor to the line should be heavy enough to allow a reasonable margin of safety, and also should be double galvanized in order to insure it against rust for as long a time as possible. The materials usually used for messenger and guy wires are, (1) very hard and strong steel, which is very difficult to work with; (2) soft iron strand, which is very easy to work with but is too soft to give good results; and (3) Siemans-Martin steel strand, which combines great strength with pliability and ease of working. Any of the materials should be double galvanized.

All messenger wires should be left slack enough so that they are not stretched to their elastic limits, which amounts can be determined for the various sized messengers from manufacturers' tables. But most practical foremen do not use a dynamometer, and judge the tightness by the sag between spans. At the points where messengers and guys dead end the poles should be protected by shims or pieces of metal so put on that the wires cannot cut into the poles.

The messenger should be supported by a hanger which will hold it firmly and permanently; the hanger should be fastened to the pole by a through bolt. The use of lag screws should be avoided.

The cable most generally used consists of soft drawn copper conductors of 19, 20, or 22 B & S gage, insulated with one or two layers of dry paper; one of the wires of each pair is usually wrapped with a colored paper to distinguish between them. The wires are then twisted together, one turn every 3 ins., then several pairs are twisted together; then another layer of pairs are twisted on the core in the opposite direction; and thus built up in alternate layers to the desired size; the core thus formed is wrapped with heavy paper and covered with an airtight lead sheath. The size of the conductor, the amount of insulation, the composition and size of the sheath and other specifications vary for the several uses to which the cable is to be put.

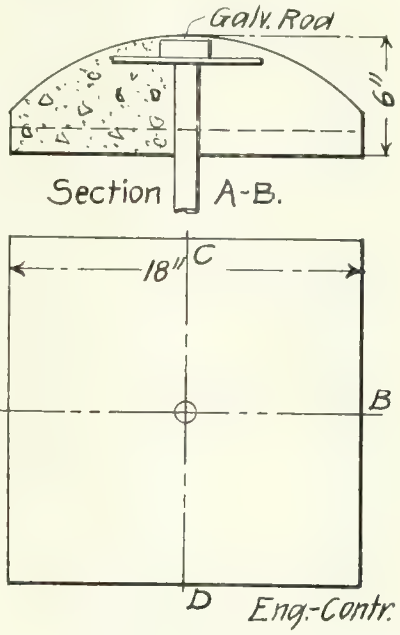


Fig. 2—Concrete Anchor.

One very important specification is the electrostatic capacity, which is varied by the distance between the wires and their insulation. Thus a change in the E. S. C. varies the price of the cable by changing the size of the lead sheath. In ordinary plants, No. 22 gage cable with an electrostatic capacity of from .09 to .12 microfarad per mile, is used, the insulation being one or two layers of dry paper and the sheath of pure lead, the thickness of which varies according to the size of the cable. For trunk cables larger conductors are ordinarily used, with lower capacity and heavier sheaths, and for underground work the lead sheath usually contains 3 per cent of tin to harden it.

Cable hangers of various types are in use, the most popular being loops of Marlin or Houselene twine hung on hooks of galvanized iron. Some companies use hangers which are made of metal. The weight and specifications of hangers depend on the size of cable to be carried.

The splicing of the cable is of great importance. The insulation of the wires must be removed, the wires twisted together and insulated with paper sleeves; care being exercised to splice white to white and red to red, etc., to keep the colors straight throughout the length of the cable. The joint when the splicing is finished should be thoroughly freed from moisture by pouring boiling paraffine over the wires, taking care that the temperature of the paraffine is high enough to boil out the moisture and not hot enough to char the insulation. The finished splice must be enclosed in an airtight cover; the best job is done by using a lead sleeve similar to the sheath and wiping the joints with solder.

There are several types of patent joints designed to enable anyone to splice and repair cable. These usually depend on gasket joints to prevent the entrance of moisture, and ordinarily are not to be recommended; except possibly for small plants which cannot afford a regular splicer and have no way to get one on short notice.

Splices must be made in all positions, vertical and horizontal, and may join the ends of one or more cables in one splice. When the poles are properly set so that in alleys or streets at crossings there are no poles, "aerial splices" are made at the crossing points of the messengers, which are substantially clamped or wired together. The two ends of the cable spliced into the main cable are lashed strongly to the main cable with Marlin twine which prevents damage to the splice from strains on either side.

The wires in the cable must be brought out at various places, in order to connect subscribers to the exchange. For this cable terminals or "cans" are used. They are of many different types, the principal types being protected and unprotected. Both types have their champions among the large operating companies, so that the choice is about evenly divided.

In one type of unprotected terminal the paper insulated wires run directly into the terminals, and the wires are soldered to binding posts which extend through the walls of the central chamber; this chamber is then filled with a waterproof compound to keep out moisture. Other types of unprotected terminals are made without the central chamber, and in order to keep moisture out of the cable it is necessary to splice rubber insulated cable on the end of the paper insulated cable. The protected terminal is connected to the cable in a manner similar to the unprotected, but at the binding posts there is furnished a lightning arrester, composed of two blocks of carbon separated by a mica strip: one block is grounded and the other attached to the line; to the line carbon is connected a fuse, and to this the terminal to which the drop wire is connected. The drop or service wire is then run, usually of twisted rubber-insulated wire, from the drop terminals to the house.

The difference in terminals can be summed up as follows: Protected terminals offer good lighting and fuse protection to the cable, thus insuring it against trouble from ordinary lighting or foreign currents, but introducing the objection of making occasional inspection necessary to clean the carbons and replace fuses; the cost is higher.

The unprotected terminals are simpler, cheaper, and require less attention; but when lightning strikes the line or a high potential wire crosses with the line, the lack of protection usually allows a large amount of damage to be done to the cable and sometimes to the entire equipment of the plant, a part of which might have been saved by using protected terminals.

When the company is not willing to have the cable entirely unprotected, and desires to reduce the construction cost, cheaper protected terminals, using rubber covered cable or potheads, may be obtained; but on account of the comparatively short life of the rubber insulation, it has been found desirable by some companies to combine the types. For instance, at the point where a cable is to branch out to serve a neighborhood the cable in run into a protected terminal and out again from the line contacts, then carried on and distributed as originally intended, using unprotected terminals. Thus, for example, in a certain multiple distribution, one 25-pair protected terminal and perhaps five 10-pair unprotected terminals will be used, which protects the main cable and reduces the cost materially.

Another method of reducing the cost and securing first class protection is by using the so-called unit type protector. This consists of an ordinary terminal with the protection mounted separately, so that only the frame is put up at first; the protection is added from time to time, as needed.

To get a number of lines into large buildings and properly distribute them on the various floors it is customary to use cables throughout the buildings, entering either aerial or underground; then running a cable to each floor, terminating in special boxes made for that purpose. This kind of construction is a trifle more expensive at first, but is very much the cheaper form in the long run.

The item of labor is such a large percentage of the cost of the line, and is ordinarily so hard to get at accurately, that figures have been appended showing average costs for the labor on certain parts of building a modern all-cable telephone plant in a suburb of a city, the population of the suburb being 3,000. These figures are as accurate as they could be kept by a good construction foreman, who, as usual, was a good bookkeeper, but the addition of a reasonable percentage for errors will give an idea of the cost for this part of the work:

	Cost Each.
Poles, unloaded, 363	$0.07
Poles shaved (average, 30 ft. long)	.22
Poles roofed (and a very few gains cut)	.07½
Poles hauled (average, 30 ft. long)	.25
Poles set (average 30 ft. long)	.33
Poles set (average 40 ft. long)	.69
Poles bored for steps	.18
Poles stepped	.20
Pole holes dug, average 30 ft., pole holes 5½ ft deep	.47½
Anchors, holes dug, 99	.45
Anchors set, 99	.58
X-arms fitted	.07
X-arms distributed	.09
X-arms put on	.15½
Guys put on	1.00
Stringing and pulling messenger, per foot	.00½
Cable pulled, average 25 pr., per ft.	.00¾
Cable clipped (hangers put on), per hanger	.00⅓
Staking out line, per pole	.10
Poles pulled and holes filled, per pole	.65
Cable unloaded, average 25 pr. per ft.	.00⅕
Drops strung, per drop	1.04
Bare wire strung, per single wire per mile	2.75

Average total cost of labor and material for splicing lead covered, paper insulated, telephone cable:

25 pr. cable	$2.86
50 pr. cable	2.95
75 pr. cable	1.40
100 pr. cable	5.75
150 pr. cable	6.22
200 pr. cable	8.37
250 pr. cable	10.00
300 pr. cable	10.00

In general a line should be substantially built of the best material obtainable for the purpose, and be constructed as nearly like the "One Horse Shay" as possible. In a well built line, certain parts will not have to be replaced from time to time, but the entire line will be serviceable **without any** rebuilding until all its parts are worn out.

The city and county of San Francisco has voted to issue $18,200,000 of bonds for municipal improvements.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0730. **Contractors' Supplies.**—J. Jacob Shannon & Co., 1744 Market St., Philadelphia, Pa.

A cloth bound book of over 600 pages, describing and illustrating all kinds of tools and machines used by contractors. Steam shovels, dinkeys, cars, derricks, unloaders, concrete mixers, boilers, engines, pumps, crushers, wagons, rollers, scrapers, cableways and all kinds of small tools and supplies are shown. The book is well indexed

No. 0731. **Testing Machinery and Instruments.**—Tinius Olsen & Co., 500 N. Twelfth St., Philadelphia, Pa.

A 17-page pamphlet illustrating and describing machines for testing cements, mortars and concretes. Besides the machines the accessories are also sold by this company. This catalog should be in the hands of all engineers making tests.

No. 0732. **Anemometer.**—Taylor Instrument Co., Rochester, N. Y.

A small pamphlet telling of portable air meter and Biram's anemometer for use of engineers. The prices of the instruments are given.

No. 0733. **The Book of The Economizer.**—The Green Fuel Economizer Co., Matteawan, N. Y.

This 158-page book proves a really valuable treatise on economizers and we give its table of contents in full, as follows: The Economizer and Its Inventor—First Experiments; Patents; Scrapers; Lids. Rival Economizers—Different Forms and Arrangements of Tubes and Headers; Circulating Economizers. Elementary Theory of the Economizer—Heat Transmission in Boilers; Profitable Amount of Heating Surface; Most Economical Rating. Forcing Capacity of Boilers—Results with Different Types; with Oil Fuel, etc. The Profit from an Economizer—The Possible Saving; High-Pressure and Superheated Steam; The Net Profit. Secondary Advantages of the Economizer—Reserve Supply of Hot Water; Prevention of Boiler Strains; Precipitation of Impurities from Water. Special Uses of the Economizer—The Junior Economizer; Hot Water for Washing; Saving Waste Heat; Salt Works; Lime Kilns; Gas Engines. Calculating the Performance of an Economizer—Example Worked Out from a Power Station Load Curve. A Simple Method of Figuring the Saving—Table and Formula Based on Rise in Temperature of Water in Economizer. Actual Saving Greater than Theoretical Saving—Figures Obtained in Preceding Chapter must be Multiplied by 1.2 to 1.4 to Give Actual Saving. Measuring the Temperature of the Flue Gases—Temperature by Colors and Melting Points; Recording Thermometers; Influence of Temperatures upon Economy. Actual Results Obtained in Economy Tests of Green Fuel Economizers—Tests in Seven Plants; Textile Mill; Railway Plant; With Oil Fuel; Manhattan Ry. Plant; With Low Temperature Flue Gases; Packing House Plant. Design and Construction of the Green Fuel Economizer—Description; Table of Sizes; Heating Tubes; Top Headers; Bottom Headers; Scrapers; Gearing; Access Branch Pipes and Connections; Circulating Economizer; Sectional Covering; Economizer Design in General. Directions for Working—Raising Steam, Blowing Out, Cleaning, Shutting Down, etc.; Inspection Service; Inspector's Duties. Green's Waste Heat Air Heater—Air Heated by Waste Gases for Use in Laundries, Textile Factories, for Heating Shops, Drying Materials, etc. The Air Heater and the Economizer in Water Gas Manufacture—Heat Recovered from Stack Valve Gases Replaces Generator and Boiler Coal, Money Saved. Chimneys—Kent's Formula and Table for Designing Chimneys. Mechanical Draft—Advantages of; Systems of Mechanical Draft; Mechanical Draft Engineering; Data Needed for Estimates; Fans for Mechanical Draft; Capacity and Power Table for Fans; Forced Draft Dampers. Steam—Properties of Steam; Factors of Evaporation. Publications of the Green Fuel Economizer Company—Describing Various Products.

CONTRACT NEWS

INDEX.

	PAGES
Bids Asked	19
Bridges	20
Buildings	20
Roads and Streets	21
Sewers	21
Water Supply	22
Excavation	22
Miscellaneous	22
Material, Machines, etc	22
Contracts Let	23

We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.		See Issue.
May 27.	Chicago, Ill.	May 6
May 27.	Columbus, Ga.	Apr. 29
May 28.	Upper Sandusky, O.	May 20
May 28.	Rushville, Ind.	May 20
May 28.	Lewisburg, Pa.	May 27
May 29.	Ionia, Mich.	May 20
May 29.	Tarrytown, N. Y	May 13
May 30.	Lincoln, Ill.	May 27
June 1.	Boonville, Ind.	May 27
June 1.	Angola, Ind.	May 27
June 1.	Summit, Pa.	May 20
June 1.	Minneapolis, Minn.	May 20
June 1.	Salem, Ind.	May 20
June 1.	Newport, Ind.	May 20
June 1.	Santa Barbara, Cal.	May 20
June 1.	Lebanon, Ind	May 20
June 1.	Kentland, Ind.	May 20
June 2.	Lima, O.	May 20
June 2.	Vicksburg, Miss.	May 20
June 2.	Vincennes, Ind.	May 20
June 2.	Bedford, Pa.	May 27
June 2.	Laporte, Ind.	May 27
June 3.	Philadelphia, Pa.	May 20
June 3.	Columbus, O.	May 20
June 4.	Goshen, Ind.	May 20
June 4.	Norwalk, O.	May 20
June 4.	Gallipolis, O.	May 27
June 4.	Eugene, Ore.	May 27
June 4.	Goshen, Ind.	May 27
June 5	Washington, Pa.	May 27
June 5	Russell, Mass	May 27
June 9.	Ottawa, Ont.	May 27
June 9.	Bloomsburg, Pa.	May 27
June 9.	Williamsport, Pa.	May 27
June 9.	Franklin, Pa	May 20
June 10	Buffalo, N. Y.	May 27
June 10.	Cleveland, O.	May 27
June 10.	Spokane, Wash.	May 27
June 11.	Hamilton, O.	May 27
June 15	St. Clairsville, O.	May 27

Buildings.

May 27	Baltimore, Md	May 20
May 27	Chicago, Ill.	May 20
May 27.	Geneva, N. Y.	May 13
May 28.	Houston, Tex	Apr. 22
May 28.	Fort Myer, Va.	May 20
May 28	New York, N. Y.	May 20
May 28.	National Military Home, Kan.	May 20
May 28.	Indianapolis, Ind.	May 27
May 29.	Fort Andrews, Mass.	May 13
May 29.	Boise, Idaho	May 13
May 29.	Fort Hancock, N. J.	May 6
May 29.	Bremerton, Wash.	May 6
May 29.	Washington, D. C.	May 27
June 1.	Eureka, Utah	May 27
June 1.	New York, N. Y	May 27
June 1.	New York, N. Y.	May 27
June 1.	Brooklyn, N. Y.	May 27
June 1.	Brooklyn, N. Y.	May 27
June 1.	Youngstown, O.	May 27
June 1.	Grand Island, Neb.	Apr. 29
June 1.	Fort Des Moines, Ia.	May 6
June 1.	Columbus Barracks, O.	May 13
June 1.	Fort Terry, N. Y.	May 13
June 1.	Fort Hancock, N. J.	May 20
June 1.	Carson City, Nev.	May 20
June 1.	Rolling Fork, Miss.	May 20
June 1	Cincinnati, Ia.	May 20
June 1.	Greensboro, Ga.	May 20
June 1.	Fort Barrancas, Fla.	May 20
June 2.	Fort Rosecrans, Cal.	May 20
June 2.	Fort Oglethorpe, Ga.	May 13
June 2.	Richmond, Va.	Apr. 8
June 2.	Albany, N. Y.	Apr. 29
June 2.	New Ulm, Minn.	Apr. 29
June 3.	Detroit, Mich.	May 6
June 3.	Baltimore, Md	May 27
June 4.	Crookston, Minn.	May 27
June 4.	Greenville, N. C.	May 27
June 4.	Chicago, Ill.	May 27
June 4.	New York, N. Y.	May 20
June 5.	Wilkesbarre, Pa.	May 13
June 6.	Annapolis, Md.	May 27
June 8.	Calgary, Alberta	May 27
June 8.	Dover, N. H.	May 6
June 9.	Ogden, Utah	May 6
June 9.	Washington, D. C.	May 20
June 10.	New Castle, Pa.	May 20
June 10.	Fort Slocum, N. Y.	May 20
June 10.	Ogden, Utah	May 6
June 10.	New Castle, Pa.	May 27
June 10.	Au Sable Forks, N. Y.	May 27
June 10.	Jersey City, N. J.	May 27
June 10.	Boswell, Ind.	May 27
June 11.	Wampsville, N. Y.	May 27
June 11.	Fort Sam Houston, Tex.	May 20
June 12.	San Luis Obispo, Cal.	May 20
June 12.	St. Charles, Mo.	May 6
June 13.	Edmonton, Alberta	May 27
June 14.	West Point, N. Y.	May 20
June 16.	Fort Worth, Tex.	May 20
June 17.	Newton, Kan.	May 13
June 18.	Houston, Tex.	May 27
June 19.	Chemawa, Ore.	May 27
June 20	Sturgeon, Pa.	May 27
June 22.	Provo, Utah	May 20
June 23.	Spokane, Wash.	May 27
June 24.	Fayetteville, Ark.	May 20
June 25.	Greenville, Tex.	May 20
June 29.	Sumter, S. C.	May 27
June 30.	Meadville, Pa.	May 20
July 1.	Baltimore, Md.	May 27
July 2.	Columbia, Tenn.	May 27
July 6.	Marietta, Ga.	May 27

Roads and Streets.

May 27.	Norristown, Pa.	May 6
May 27.	Bedford, Pa.	May 6
May 27.	Conneaut, O.	May 20
May 27.	Baltimore, Md.	May 20
May 28.	Chicago, Ill.	May 20
May 28.	Brooklyn, N. Y.	May 20
May 28.	New York, N. Y.	May 20
May 28.	Honesdale, Pa.	May 6
May 28.	Clarion, Pa.	May 6
May 28.	Aurora, Ill.	May 27
May 29.	Wilkesbarre, Pa.	May 27
May 29.	Lincoln, Neb.	May 27
May 29.	Milwaukee, Wis.	May 20
May 29.	Winchester, Ind.	May 20
May 29.	Valparaiso, Ind.	May 20
May 29.	Westerville, O.	May 6
May 29.	Pauling, O.	May 13
May 30.	Greencastle, Ind.	May 20
June 1.	Doylestown, Pa.	May 20
June 1	Fort Stevens, Ore.	May 20
June 1.	Hackensack, N. J.	May 20
June 1.	Vicksburg, Miss.	May 20
June 1.	Williamsport, Ind.	May 20
June 1.	New Castle, Ind.	May 20
June 1.	Lawrenceburg, Ind	May 20
June 1.	Decatur, Ind.	May 20
June 1.	Atlanta, Ga.	May 20
June 1.	Fort Pickens, Fla.	May 20
June 1.	Doylestown, Pa.	May 6
June 1.	Fort Lyon, Me.	May 6
June 1.	Fort Slocum, N. Y.	May 6
June 1.	Fort Slocum, N. Y.	Apr. 22
June 1.	New Brunswick, N. J.	May 13
June 1.	Fort Andrews, Mass.	May 13
June 1.	Tipton, Ind.	May 13
June 1.	Jasper, Ind.	May 13
June 1.	Franklin, Ind.	May 13
June 1.	Fort Benjamin Harrison, Ind.,	May 13
June 1.	Kansas City, Mo.	May 27
June 1.	Cincinnati, O.	May 27
June 1	Escanaba, Mich.	May 27
June 1.	Fremont, Neb.	May 27
June 1.	Westminster, Md.	May 27
June 1	Indianapolis, Ind.	May 27
June 1.	Sioux City, Ia.	May 27
June 2	Winamac, Ind.	May 20
June 2	Valparaiso, Ind.	May 20
June 2.	Paoli, Ind.	May 20
June 2.	Brownstown, Ind.	May 20
June 2	Bayonne, N. J.	May 27
June 3.	Columbus, O.	May 27
June 3.	Chicago, Ill.	May 27
June 3	Baltimore, Md.	May 27
June 3	Winchester, Ind.	May 27
June 3.	Belleville, Ill.	May 27
June 3.	Brooklyn, N. Y.	May 27
June 3	Peru, Ind.	May 20
June 4.	Frankfort, Ind.	May 13
June 4	Kansas City, Mo.	May 27
June 4.	Logansport, Ind.	May 27
June 4.	Chicago, Ill.	May 27
June 5	Brookville, Ind.	May 20
June 5	West Chester, Pa.	May 20
June 5	Tipton, Ind.	May 20
June 6	Delphi, Ind	May 20
June 6	Crawfordsville, Ind.	May 13
June 6	Fort Niagara, N. Y.	May 27
June 8	Camden, N. J.	May 27
June 8	Latrobe, Pa.	May 27
June 8.	Mt. Kisco, N. Y.	May 27
June 8.	Newark, N. J.	May 13
June 8.	Cape May C. H., N. J.	May 20
June 9.	Portland, Ind	May 13
June 9.	Cambridge City, Ind.	May 27
June 15.	Montgomery, Ala.	May 27
June 15	Fort Barrancas, Fla.	May 20
June 17.	Harrisburg, Pa	May 27
June 18.	Harrisburg, Pa	May 27
June 19.	Bellefonte, Pa.	May 27
June 20.	Butler, Pa.	May 27
June 22.	Aberdeen, S. Dak	May 27
June 22.	Fort Dade, Fla.	May 27
July 1	Fort Barrancas, Fla	May 27

Sewers.

May 27.	Baltimore, Md	May 6
May 27.	Conneaut, O.	May 20
May 27.	Louisville, Ky.	May 20
May 28	Johnson City, Tenn.	May 20
May 28.	Chillicothe, O.	May 13
May 28.	Monmouth, Ill.	May 27
May 28.	Decatur, Ill.	May 27
May 29	Kankakee, Ill.	May 27
May 29.	St. Louis, Mo.	May 20
June 1.	Iron Mountain, Mich.	May 20
June 1.	Shelby, N. C.	May 13
June 1.	Steubenville, O.	May 27
June 1.	Mason City, Ia.	May 27
June 1.	Dayton, Ky	May 27
June 1.	Mishawaka, Ind.	May 27
June 1.	Indianapolis, Ind.	May 27
June 2.	Bayonne, N. J.	May 27
June 2	Middletown, O.	May 27
June 2.	Brazil, Ind.	May 27
June 2.	Frankfort, Ind	May 20
June 3.	Philadelphia, Pa.	May 20
June 3.	Brooklyn, N. Y.	May 13
June 3.	Brooklyn, N. Y.	May 27
June 3.	Belleville, Ill.	May 27
June 4.	Emsworth, Pa.	May 20
June 4.	Atchison, Kan.	May 20
June 6.	Sullivan, Ind.	May 13
June 8.	Aberdeen, S. Dak.	May 20
June 9.	Cambridge City, Ind.	May 27
June 10.	Oakland, Cal.	May 20
June 10.	Brooklyn, N. Y.	May 27

Water Supply.

May 29.	Owego, N. Y.	May 20
May 30.	Columbus, Miss.	Apr. 22
June 1.	Fort Monroe, Va.	May 13
June 1.	Shelby, N. C.	May 13
June 1.	Grand Forks, N. Dak	May 20
June 1.	Fort Mason, Cal.	May 20
June 1.	Dallas, Tex	May 27
June 1	Joliet, Ill.	May 27
June 2.	Grafton, N. Dak.	May 20
June 2	Grafton, N. Dak.	May 20
June 4.	Milwaukee, Wis.	May 20
June 4.	Chicago, Ill.	May 27
June 5.	Michigan City, Ind.	May 27
June 6.	Neosho, Mo.	May 13
June 8.	Velva, N. Dak	May 20
June 9.	Kimberly, Nev.	May 20
June 9.	Mont Alto, Pa.	May 27
June 10	Brooklyn, N. Y.	May 27
June 10.	Brooklyn, N. Y.	May 27
June 10	Baltimore, Md.	May 20
June 15	Fort St. Philip, La.	May 20
June 16.	Wahpeton, N. Dak.	May 27
June 18.	Springfield, Mass.	May 27

Miscellaneous.

May 27.	Washington Barracks, D. C.,	Laying Cable,	May 13
May 29	Philadelphia, Pa.,	Fencing,	May 27
June 1.	Fort Standish, Miss.,	Wharf,	May 6
June 1.	Fort Lyon, Me.,	Wharf,	May 6
June 1.	Fort Rodman, Mass.,	Wharf Work,	Apr. 29
June 1	Fort Slocum, N. Y.,	Sea Wall,	Apr. 22
June 1	Fort Mansfield, R. I.,	Repairing Bulkhead,	May 13
June 1.	Fort Michie, N. Y.,	Signal Tower,	May 13
June 1.	Boston, Mass.,	Lock Gate House,	May 13
June 1	Reno, Nev.,	Power House,	May 20
June 1	Carthage, O.,	Arc Lighting System,	May 20
June 2	Toronto, Ont.,	Power Transmission Line,	May 20
June 2	New York, N. Y.,	Rondout Siphon,	May 13
June 2	Chicago, Ill.,	Coal Hopper,	May 27
June 2	Chicago, Ill.,	Laying Cable,	May 27
June 3	Brooklyn, N. Y.,	Fencing,	May 27
June 4	New London, Conn.,	Light House,	May 13
June 10	Memphis, Tenn.,	Levee Work,	May 13
June 10	Washington, D. C.,	Launches	May 20
July 13	Harrisonburg, La.,	Lock and Dam,	May 13
July 15	Sunnyside, Wash.,	Wasteway Channel, Etc.,	May 13
June 16	Carrollton, Miss.,	Electric Plant,	May 27
July 8	St. Andrews, Man.,	Dam, Etc.,	May 27

July 17. Los Angeles, Cal., Aqueduct, May 27
Aug. 14. Portland, Ore., Light House, May 27

Excavation, Earth and Rock.

May 27. Evanston, Ill., Excavation, Etc., May 13
May 27. Chicago, Ill., Excavation, Dock, May 13
May 27. Crookston, Minn., Ditch, May 20
May 27. Monticello, Ind., Ditch Work, May 20
May 28. Woods Cross, Utah, Water Channel, May 27
May 29. Wilmington, Del., Dredging, May 6
May 30. Bluffton, Ind., Ditch, May 20
May 30. Frankfort, Ind., Ditch, May 27
June 1. Kansas City, Mo., Grading, May 27
June 1. Jackson, Minn., Ditch Work, May 20
June 1. Osnabruck Center, Ont., Drain, Apr. 22
June 1. Fort Slocum, N. Y., Earth Filling, Apr. 22
June 1. Fort H. G. Wright, N. Y., Grading, May 13
June 1. Fort Monroe, Va., Filling, May 13
June 1. Eldora, Ia., Ditch, May 13
June 2. Salt Lake City, Utah, Excavation, May 27
June 3. Elk Point, S. Dak., Ditch, May 20
June 3. New York, N. Y., Embankment, May 27
June 4. St. Paul, Minn., Ditch Work, May 20
June 4. Chicago, Ill., Grading, Retaining Wall, May 27
June 10. Fort Dodge, Ia., Tile Drain, May 13
June 10. Fairmont, Minn., Ditch Work, May 20
June 16. Memphis, Tenn., Levee Work, May 20

Materials, Machines, Supplies, Tools, Etc.

May 27. Superior, Wis., Metal Vault Shelving, May 6
May 27. Leavenworth, Kan., Electrical Supplies, May 6
May 27. San Francisco, Cal., Asphalt Plant, May 20
May 28. New York, N. Y., Broken Stones, May 20
May 28. Galveston, Tex., Pumping Equipment, May 13
June 1. Sandusky, O., Boilers, May 13
June 1. Benicia, Cal., Cement, Lumber, Etc., May 13
June 1. Washington, D. C., Portland Cement, Apr. 29
June 1. Yonkers, N. Y., Pipe and Specials, May 20
June 1. Decatur, Ind., Crushed Stone, May 20
June 1. Youngstown, O., Pipe, Valves, Etc., May 27
June 1. New York, N. Y., Broken Stone, May 27
June 2. New York, N. Y., Pipe, Lumber, Etc., May 27
June 2. New York, N. Y., Box Cars, May 27
June 2. Irvington, N. J., Crushed Stone, May 27
June 2 Washington, Ind., Gravel, May 20
June 2 Cincinnati, O., Pipe, Castings, May 13
June 2 Washington, D. C., Pumps, Tie Plates, Etc., May 13
June 3. Tompkinsville, N. Y., Supplies, May 13
June 6 New Orleans, La., Rock, May 20
June 6. Carson City, Nev., Pipe, May 27
June 6. New Orleans, La., Rock, May 27
June 6. Washington, D. C., Pipe, May 27
June 7. Easton, Pa., Fire Hose, May 20
June 8. Watertown, Mass., Iron, Steel, Lumber, May 20
June 9. New Orleans, La., Lumber, Piling, Etc., May 17
June 9. Fort Wood, N. Y. H., Engine, May 20
June 10. Rome, N. Y., Pipe, Specials, May 27
June 10. New York, N. Y., Traveling Cranes, May 27
June 10. Brooklyn, N. Y., Pipe, Tools, Etc., May 27
June 15. Edmond, Okla., Water Works Material, May 27
June 16. Quincy, Mass., Electric Hoists, Apr. 8
June 19. Minidoka, Idaho, Electrical Apparatus, May 27
June 30. New Orleans, La., Machinery, Apr. 22

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Lincoln, Ill.—Until May 30, by Wm. H. Diecker, Clerk, for repair work on bridge over Salt Creek in Chester Township.

Angola, Ind. Until 1 p. m., June 1, by Thos. L. Gillis, County Auditor, for one 54 ft. by 14 ft. steel bridge and one 60 ft. by 14 ft. steel bridge.

Boonville, Ind.—Until 2 p. m., June 1, by R. F. Cherry, County Auditor, for constructing 11 bridges.

Goshen, Ind.—Until 9:30 a. m., June 4, by D. O. Batchelor, County Auditor, for repairs to seven bridges and erection of following bridges and arches: No. 8, 22x16 ft. bridge; No. 10, 12x16 ft.; No. 11, 24x16 ft.; No. 13, 24x16 ft.; No. 15, 75x16 ft.; No. 16, 24x16 ft.; No. 17, 60x20 ft.; No. 18, 24x16 ft.; No. 19, 24x16 ft.; No. 20, 16x16 ft.; No. 21, 30x16 ft.; No. 22, 40x16 ft.; No. 23, 40x20 ft.; No. 24, 12x16 ft., No. 25, 6x16 ft.; No. 26, 12x16 ft.; No. 32, 30x16 ft.

Laporte, Ind.—Until 10 a. m., June 2, by Chas. H. Miller, County Auditor, for the construction of the Closser bridge and abutments in Kankakee Township and the Davey bridge and abutments in Washington Township.

Russell, Mass.—Until 2 p. m., June 5, by Bridge Committee, E. D. Parks, Secretary, for furnishing superstructure of a bridge over the Westfield River. Bridge consists of two spans, each span of about 122 ft. in the clear; roadway, 20 ft. wide; sidewalk, 5 ft. wide. Oren E. Parks, Westfield, Mass., is Engineer.

Buffalo, N. Y.—Until noon, June 10, by Western New York Construction Co., 535 Brisbane Bldg., Buffalo, for the construction of a reinforced concrete viaduct for highway and street railway trave', to be 1,400 ft. long with 40-ft. roadway and two 5-ft sidewalks; contractors to submit their own designs with proposals.

Cleveland, O.—Until 11 a. m., June 10, by County Commissioners, Wm. F. Black, Clerk, for the construction of bridge work per: Report No. 1873, new bridge, Warrensville Township; Report No. 1881, new culvert, Orange Township; Report No. 1882, cast-iron pipe culvert, Chagrin Falls Township; Report No. 1885, new bridge, Cleveland Heights Township; Report No. 1886, new bridge, Cleveland Heights Township; Report No. 1888, concrete bridge, Bay Village (Dover) Township. A. B. Lea, County Surveyor.

Gallipolis, O.—Until June 4, by F. F. Thorniley, County Auditor, for bridge construction in several townships.

Hamilton, O.—Until 10 a. m., June 11, by J. E. Brate, County Auditor, for repair of west abutment of bridge over Seven Mile Creek in Milford Township.

St. Clairsville, O.—Until 1 p. m., June 15, by A. W. Beatty, County Auditor, for constructing following bridges: Lucas Bridge, concrete or stone substructure, 30 ft. steel superstructure; Provident Bridge, concrete or stone substructure with reinforced concrete top; Walker Bridge, stone substructure and steel superstructure, 35 ft. long; Patton Bridge, stone or concrete substructure with reinforced concrete top; Mead Bridge or culvert, stone substructure with reinforced concrete top; Water Works Bridge, stone or concrete substructure with reinforced concrete top; Barton Bridge No. 1, stone or concrete substructure, reinforced concrete top.

Eugene, Ore.—Until 2 p. m., June 4, by E. U. Lee, County Clerk, for constructing 50 ft. span, Howe truss bridge over Edwards Slough.

Bedford, Pa.—Until June 2, by County Commissioners, James F. Mickel, Clerk, for constructing one span steel bridge over Dunnings Creek in East St Clair Township.

Bloomsburg, Pa.—Until 10 a. m., June 9, by County Commissioners, Bruce Black, Clerk, for constructing three steel beam bridges.

Lewisburg, Pa.—Until noon, May 28, by County Commissioners, A. J. Steese, Clerk, for repairing and putting in steel joists in Lewisburg bridge.

Philadelphia, Pa.—As stated in our issue of last week bids are being asked until June 3 by the Director of Public Works, George R. Stearns, for constructing bridges. The work includes the following: 42d St., over the Pennsylvania R. R., steel arch bridge, 57 ft. wide; span, 25 ft.; amount available, $112,000. 61st St., over the Philadelphia and Baltimore Ry., to replace old wooden bridge: steel deck plate girder bridge, encased in concrete, 59 ft. 6 in. wide; span, 71 ft.; estimated cost, $45,000. Northeast Blvd., concrete arch bridge over the Oxford branch of the Connecting Ry., 100 ft. wide; span, 39 ft.; amount available, $60,000. Northeast Blvd., over Reading Ry., reinforced concrete arch bridge, 100 ft. wide; span, 60 ft.; amount available, $50,000. Single-track ballasted floor-plate girder bridge to carry the Reading's Frankford branch over Large St., to consist of one center span of 60 ft. and two side spans each 22 ft., with masonry abutments to provide for a second railway track.

Washington, Pa.—Until June 5, by State Highway Department, J. W. Hunter, Commissioner, Harrisburg, for constructing reinforced concrete viaduct on National Pike in Washington County.

Williamsport, Pa.—Until noon, June 9, by County Commissioners, Frank L. Miller, Clerk, for constructing three concrete steel bridges and two stone arch bridges.

Spokane, Wash.—Until 2 p. m., June 10, by Board Public Works, J. T. O'Brien, Secretary, for construction of a permanent improvement, 785 ft. long, on Sprague Ave., from west line of Ivory St. to a point 785 ft. westerly therefrom. The improvement contemplates one of four plans: (1) A steel girder viaduct, supported on tower bends; (2) a reinforced concrete viaduct; (3) reinforced concrete retaining walls with earth or rock fill; (4) dry retaining walls with rock fill. Official advertisement will be found elsewhere in this issue.

Ottawa, Ont.—Until noon, June 9, by Commissioners Transcontinental Ry., P. E. Ryan, Secretary, for construction and erection of steel superstructures and floor system required for 11 bridges in District A.

St. Andrews, Man.—See under Bids Asked—Miscellaneous.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Until 2 p. m., May 29, by District Commissioners, District Bldg., for furnishing and installing metal cabinet work in new municipal building.

Marietta, Ga.—Until 3 p. m., July 6, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction complete of the U. S. Post Office at Marietta.

Chicago, Ill.—Until 11 a. m., June 4, by Department Public Works, 322 City Hall, for addition and alteration to the fire department repair shop and paint shop and the first district headquarters of the water pipe extension, located at 195-203 Sebor St.

Boswell, Ind.—Until June 10, by School Board, for steam and hot water heating plant in school building.

Indianapolis, Ind.—Until 10 a. m., May 28, by State Board of Agriculture, Room 14, State House, for construction of a brick and frame horse barn on Indiana State Fair Grounds.

Annapolis, Md.—Until noon, June 6, by Truman H. Newberry, Acting Secretary War Department, for granite and for iron and copper cornice work and lantern sash for the power house at the U. S. Naval Academy, Annapolis, Md. Ernest Flagg, Architect, 35 Wall St., New York.

Baltimore, Md.—Until 11 a. m., June 3, by Alfred M. Quick, Water Engineer, City Hall, for alterations and additions to stable at Gay St.

Baltimore, Md.—Until 3 p. m., July 1, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction and mechanical equipment (except plumbing) of an extension to the U. S. Post Office, Court House, etc., at Baltimore.

Crookston, Minn.—Until June 4, by Board of Education, Edw. Peterson, Secretary, for erection of Franklin school building; three stories, 80x84 ft.

Greenville, N. C.—Until 11 a. m., June 4, by Thos. J. Jarvis, Chairman Executive Committee East Carolina Teachers' Training School, for erection and completion of an administration building, two dormitories and a refectory. Hook & Rogers, Architects, Charlotte, N. C.

Jersey City, N. J.—Until 3 p. m., June 10, by New County Building Committee, A. J. Clements, Secretary, 573 Newark Ave., for materials and labor for interior work of new court house and the power house building. Hugh Roberts, Architect, 1 Exchange Pl., Jersey City.

Au Sable Forks, N. Y.—Until 10 a. m., June 10, by Board of Education, F. L. Kemp, Clerk, for erection of 2-story and basement school building about 72x78 ft.

Brooklyn, N. Y.—Until 2:30 p. m., June 1, by Robert W. Hebberd, Commissioner of Charities, foot of E. 26th St., New York, for providing all labor and materials required for the erection and entire completion (with the exception of fitting up) of a new pathological building at the King's County Hospital, Borough of Brooklyn. Security required is $15,000. Raymond F. Almirall, Architect, 51 Chambers St., New York.

Brooklyn, N. Y.—Until 11 a. m., June 1, by C. B. J. Snyder, Superintendent of School Buildings, Park Ave. and 59th St., New York, for the following work: General construction of new public school 162, security required $125,000; general construction, etc., of additions to public school 128, security required $60,000; installing heating and ventilating apparatus in new public school 156, security required $35,000; improvements and new cottage at public school 120, Barren Island, security required $8,000.

New York, N. Y.—Until 11 a. m., June 1, by C. B. J. Snyder, Superintendent of School Buildings, Park Ave. and 59th St., for the general construction, etc.. of additions to public school 30, security required $60,000.

New York, N. Y.—Until 2 p. m., June 1, by John F. Ahearn, Borough President, for repairs and alterations to city court house; security required is $20,000. Charles I. Berg, Architect, 571 Fifth Ave.

Wampsville, N. Y.—Until 1 p. m., June 11, by County Building Committee, at office of E. Leland Hunt, Attorney, Oneida, N. Y., for the erection of a new court house and jail at Wampsville, N. Y. J. Riely Gordon, 402 Fifth Ave., New York City, is Architect for the Court House; Wm. J. Beardsley, Poughkeepsie, N. Y., is Architect for the Jail.

Youngstown, O.—Until June 1, by Board of Education, W. N. Ashbaugh, Clerk, for the construction of a 10-room stone and brick school building of fireproof construction on the corner of Bissell and Kensington Ave.

Chemawa, Ore.—Until 2 p. m., June 19, by Commissioner of Indian Affairs, Washington, D. C., for boiler, smokestack, and extension to power house at Salem school. Further information may be obtained from E. L. Chalcraft, Superintendent, Chemawa.

New Castle, Pa.—Until noon, June 12, by Board of School Controllers, W. J. Chain, Secretary, for the erection of a brick and terra cotta fireproof high school building. W. G. Eckles, Architect, New Castle, Pa.

Sturgeon, Pa.—Until June 20, by P. H. Wacker, President, Sturgeon Aerie, Fraternal Order of Eagles, for the erection and completion of a 3-story lodge room, hall and club room of brick and concrete. Plans and specifications may be obtained from John Kessler, of the Building Committee, at Noblestown, Pa.

Sumter, S. C.—Until 3 p. m., June 29, by James Knox Taylor, Supervising Architect, Washington, D. C., for construction, including plumbing, gas piping, heating apparatus and electric conduits and wiring of U. S. Post Office at Sumter.

Columbia, Tenn.—Until 3 p. m., July 2, by James Knox Taylor. Supervising Architect, Washington, D. C., for the construction, including plumbing, gas piping, heating apparatus, electric conduits and wiring of U. S. Post Office at Columbia.

Houston, Tex.—Until 3 p .m., June 18 (extension of time from May 18), by James Knox Taylor, Supervising Architect, Washington, D. C., for construction of U. S. Post Office and Court House at Houston.

Eureka, Utah.—Until June 1, by James D. Stack, President Library Trustees, for erection of a library building. Watkins & Birch, Architects, 525 Dooly Block, Salt Lake City, and 335 Academy Ave., Provo.

Calgary, Alberta.—Until June 8, by Hospital Board, for erection of a new general hospital building. F. J. Lawson, Architect, Calgary.

Edmonton, Alberta.—Until June 13, by John Stocks, Deputy Minister of Public Works, for erection of a Court House in this city.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Montgomery, Ala.—Until noon, June 15, by Robert Tait, City Treasurer, for paving the roadway of North Court St. from the south side of Pollard St. to the city limits, with asphalt, brick, bitulithic or Belgian blocks, in accordance with specifications in the office of A. R. Gilchrist, City Engineer. Certified check for $5,000 required with bid.

Fort Barrancas, Fla.—Until 11 a. m., July 1, by Capt. D. W. Hand, Constructing Q. M., for construction of new and resurfacing of old roads at this post.

Fort Dade, Fla.—Until 8 p. m., June 22, by the Constructing Quartermaster, for construction of brick roads.

Sioux City, Ia.—Until 2 p. m., June 1, by E. E. Hosmer, County Auditor, for grading and oiling of certain streets and highways in Sioux City Township.

Aurora, Ill.—Until 2 p. m., May 28, by M. J. Tarble, City Engineer for construction 11,000 sq. yds. sheet asphalt pavement, 3,440 sq. yds brick pavement, and 8,000 ft. combined curb and gutter.

Belleville, Ill.—Until 3 p. m., June 3, by Fred J. Kern, President Board Local Improvements, for 60,000 sq. yds. of vitrified brick paving, including 20,000 ft. of sewering and 40,000 lin. ft. of curbing. Official advertisement will be found elsewhere in this issue.

Chicago, Ill.—Until 10:30 a. m., June 4, by Board Local Improvements, Charles A. V. Standish, Secretary, 203 City Hall, for five contracts for paving with vitrified brick, three contracts for paving with blast furnace slag, 13 contracts for asphalt, one contract for limestone and one contract for granite block paving.

Chicago, Ill.—Until 10:30 a. m., June 3, by Board Local Improvements, Charles A. V. Standish, Secretary, 203 City Hall, for the work under 38 contracts for constructing cement sidewalks.

Cambridge City, Ind.—Until 7:30 p. m., June 9, by Town Clerk, for constructing 1,500 lin. ft. of 4 ft., and 2,200 ft. of 5 ft. cement sidewalk, 2,500 ft. of cement curb and gutter and 2,000 ft. of resetting stone curb and placing new cement gutter. Bids are also asked for constructing storm sewer in Main St. and grading street. Chas. Brossmann, Consulting Engineer, Union Trust Bldg., Indianapolis. Official advertisement will be found elsewhere in this issue.

Indianapolis, Ind.—Until 10 a. m., June 1, by Board Public Works, for six contracts for grading and paving roadway, two contracts grading and paving sidewalks and one contract for resurfacing roadway.

Logansport, Ind.—Until 10 a. m., June 4, by Commissioners of Cass and Miami Counties, for constructing gravel road.

Winchester, Ind.—Until 1 p. m., June 3, by Mack Pogue, County Auditor, for improvement of highway with crushed stone.

Baltimore, Md.—Until 11 a. m., June 3, by Commissioners for Opening Streets, Hoen Bldg., for grading, curbing, guttering and paving with vitrified brick, sheet asphalt, asphalt blocks or bitulithic, portions of 24th St. and North Ave. Separate bids will also be received for grading North Ave.

Westminster, Md.—Until noon, June 1, by County Commissioners, F. L. Hahn, Clerk, for grading and macadamizing about ¾ mile of the Eldersburg Road, Sec. B.

Escanaba, Mich.—Until noon, June 1, by A. P. Smith, County Clerk, for grading and macadamizing 5¾ miles (three sections) of the Bark River road.

Kansas City, Mo.—Until 3 p. m., June 1, by Board of Park Commissioners, Frank P. Gossard, Secretary, for paving 39th St., from Oak St. to Kenwood Ave.

Kansas City, Mo.—Until 11 a. m., June 4, by E. A. Harper, City Engineer, for constructing artificial stone sidewalks on portions of 10 streets; also for constructing artificial stone curbing on portions of two streets.

Fremont, Neb.—Until 7:30 p. m., June 1, by E. N. Morse, Chairman Board Public Works, for labor and material for paving and curbing District No. 14. Estimated cost is $20,605.

Lincoln, Neb.—Until noon, May 29, by Thos. H. Pratt, City Clerk, for grading, paving and curbing roadway of H. St., O. St., and 27th St.

Bayonne, N. J.—Until 8 p. m., June 2, by W. C. Hamilton, City Clerk, for asphalt paving on 35th St., 8,200 sq. yds.; on 39th St., 3,150 sq. yds., and on 28th St., 4,750 sq yds. F. W. Dalrymple, City Engineer.

Camden, N. J.—Until 11 a. m., June 8, by Fred W. George, County Clerk, for macadamizing Evesham Road from White Horse Turnpike, to Blackwoodtown Turnpike, a distance of 2.43 miles. Also for macadamizing 2d Section of Blackwoodtown Turnpike from Chews to Blackwood, a distance of 2.4 miles, using asphaltum oil for binder.

Brooklyn, N. Y.—Until 11 a. m., June 3, by Bird S. Coler, Borough President, for work under four contracts for street improvement. Largest contract calls for regulating and paving with asphalt on a concrete foundation the roadway of 14th Ave. from 45th St. to 60th St, the engineer's estimate of the quantities being as follows: 19,230 sq. yds. asphalt pavement, 2,090 cu. yds. concrete.

Fort Niagara (P. O., Youngstown), N. Y.—Until June 6, by Constructing Q. M., for constructing concrete walks at this post.

Mt. Kisco, N. Y.—Until 3:30 p. m., June 8, by Joseph E. Merriam, Town Clerk, for grading and macadamizing about 3 1-3 miles of road. Byrne & Darling, Engineers, White Plains, N. Y.

Cincinnati, O.—Until noon, June 1, by Board Public Service, John J. Wenner, Clerk, for resurfacing Shillito Place with asphalt. Bond for $1,000 required with bid.

Columbus, O.—Until noon, June 3, by E. W. Hirsch, Secretary Board Public Service, for grading and paving portions of 14 streets.

Bellefonte, Pa.—Until June 19, by State Highway Department, Harrisburg, Pa., for constructing 7,560 ft. of Osceola Road and 7,507 ft. of Tyrone Pike in Rush Township, Center County, and 6,044 ft. of road in Harris Township, Center County.

Butler, Pa.—Until June 20, by State Highway Department, Harrisburg, for constructing 15,000 ft. of road in Butler Township, Butler County.

Harrisburg, Pa.—Until June 17, by State Highway Department, Harrisburg, for construction of following roads: Salisbury Road, 4,900 ft. long, and Summit Mills Road, 6,200 ft. long, in Summit Township, Somerset County; 8,700 ft. of road in West Penn Township, Schuylkill County; 27,783 ft. of road in Porter Township, Huntingdon County.

Harrisburg, Pa.—Until June 18, by State Highway Department, Harrisburg, for the construction of the following roads: 2,997 ft. of road in Ulster Township, Bradford County; 8,174 ft. of road in Monroe Township, Snyder County; two sections, 3,450 ft. and 5,855 ft., of Jonestown Road, in Susquehanna Township, Dauplin County; 8,350 ft. of road in Lower Paxton Township, Dauphin County.

Latrobe, Pa.—Until 8 p. m., June 8, by Jas. C. Oursler, Borough Secretary, for improvement of South Ligonier St., by 9,600 cu. yds. grading, setting 8,000 ft. of stone curb, and laying 13,800 sq. yds. of brick or asphaltum block.

Wilkesbarre, Pa.—Until May 29, by H. C. Mason, Contractor, 67 Public Square, Wilkesbarre, for macadamizing Lee Park Ave. from Division St. to St. Mary's Cross Road, a distance of 3,450 ft., and St. Mary's Cross Road from Lee Park Ave. to the Middle Road, a distance of 500 ft.

Aberdeen, S. Dak.—Until 8 p. m., June 22, by F. W. Raymond, City Auditor, for paving portions of several streets with creosote blocks, brick or asphalt.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Mason City, Ia.—Until 8 p. m., June 1, by J. H. McEwen, City Clerk, for constructing sewers as follows: 2,351 ft. 15-in., 598 ft. 12-in., 687 ft. 10-in., and 6,138 ft. 8-in. pipe; also 28 brick manholes.

Belleville, Ill.—Until 3 p. m., June 3, by Fred J. Kern, President Board Local Improvements, for constructing 20,000 ft. of sewers.

Decatur, Ill.—Until 2 p. m., May 28, by Board Local Improvements, A. B. Alexander, Engineer, for constructing 12-in. sewer.

Kankakee, Ill.—Until 4 p. m., May 29, by City Clerk, for constructing lateral sewer.

Monmouth, Ill.—Until 11 a. m., May 28, by Board Local Improvements, J. S. Bates, City Engineer, for constructing 12-in. sewer in East Euclid Ave.

Brazil, Ind.—Until 7 p. m., June 2, by F. K. De Armney, City Clerk, for construction of Pogue's Run storm and sanitary sewer. Estimated cost is $33,724, and sewer is to be constructed of reinforced concrete, 2,700 ft. being 4x5 ft., and 2,900 ft. being 5x12 ft.

Cambridge City, Ind.—Until 7:30 p. m., June 9, by Town Clerk, for constructing storm sewer in Main St. See also under Bids Asked—Roads and Streets.

Indianapolis, Ind.—Until 10 a. m., June 1, by Board Public Works, for constructing local sewers in Chicago St. and Highland Ave.

Mishawaka, Ind.—Until June 1, by this city, for constructing Logan St., Laurel St., and East End trunk sewers, also the East 4th St. and West 2nd St. laterals. The trunk sewers will be 36 in. and 42 in., and the laterals will be 10 in. to 18 in. Estimated cost is $66,000. W. S. Moore is City Engineer.

Dayton, Ky. Until 8 p. m., June 1, by City Clerk, for constructing vitrified brick or concrete sewer in Main St., McKinney St. and Vine St. Certified check for $500 required with bid. Geo. G. Lindsey, City Engineer, 7 East 4th St., Newport, Ky.

Bayonne, N. J.—Until 8 p. m., June 2, by W. C. Hamilton, City Clerk, for constructing sewers as follows: Sewer in Ave. F., amount of concrete pipe on piles about 650 ft. of from 30 to 24 in. in diameter; vitrified pipe 2,000 ft., from 24 in to 12 in. Sewer in Railroad Ave., 24 in. concrete pipe on piles about 100 ft.; 1,900 ft. of vitrified pipe from 10 in. to 24 in. in diameter. F. W. Dalrymple, City Engineer.

Brooklyn, N. Y.—Until 11 a. m., June 10, by Bird S. Coler, Borough President, for constructing sewer in E. 8th St., to cost about $3,557.

Brooklyn, N. Y.—Until 11 a. m., June 3, by Bird S. Coler, Borough President, for four contracts for constructing relief sewers. Estimated total of contract No. 1 is $366,135; contract No. 2, $380,650; contract No. 3, $354,297; contract No. 4, $34,917.

Middletown, O.—Until noon, June 2, by John Kunz, Clerk Board Public Service, for labor and materials for constructing pipe sewers, the work including 2,100 ft. 12-in., 3,016 ft. 15-in., 884 ft. 18-in., 450 ft. 24-in., 21 manholes and 41 inlet basins.

Steubenville, O.—Until noon, June 1, by Board Public Service, H. G. Simpson, Clerk, for constructing 12-in. vitrified pipe sewer in Alley B. Certified check for $200 required with bid.

Philadelphia, Pa.—Bids are being asked until June 3, by George R. Stearns, Director Public Works, for constructing main sewers as stated in our issue of last week. They include a brick sewer from 9 to 10 ft. diameter in Eastwick Ave. from 64th to 67th Sts., probable cost, $40,000; brick sewer 4 ft. diameter, in Schuyler St., from Roberts Ave. to Clapier St., $15,000, and reconstruction of a brick sewer from 8 ft. 6 in. to 11 ft. diameter in Clearfield St., between 12th and 6th Sts., $70,000.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Chicago, Ill.—Until 10:30 a. m., June 4, by Board Local Improvements, Charles A. V. Standish, Secretary, 203 City Hall, for work under 10 contracts for constructing water mains.

Joliet, Ill.—Until 10 a. m., June 1, by Board Local Improvements, William S. Welch, Clerk, for constructing water mains in Franklin and Ohio Sts.

Michigan City, Ind.—Until 11 a. m., June 5, by Lake Michigan Water Co., Fred C. Miller, Secretary, for furnishing material and labor for the construction of a submerged intake crib and the laying of a 30-in. intake pipe.

Springfield, Mass.—Until 2 p. m., June 18, by Water Commissioners, E. E. Lochridge, Chief Engineer, for the construction of a covered masonry reservoir with gate houses, dwelling and appurtenances, as included under Little River Water Supply, Contract No. 3. The reservoir will cover an area of 92,000 sq. ft. and will have a depth of 26 ft.

Wahpeton, N. Dak.—Until 2 p. m., June 16, by Commissioners of Indian Affairs, Washington, D. C., for improvements to water system at Wahpeton Indian School. Further information may be obtained from J. C. Clifford, Superintendent, Wahpeton.

Brooklyn, N. Y.—Until 2 p. m., June 10, by John H. O'Brien, Commissioner Water Supply, Gas and Electricity, 13 Park Row, New York, for hauling and laying water mains in four districts in the Borough of Brooklyn.

New York, N. Y.—Until 2 p. m., June 10, by John H. O'Brien, Commissioner Water Supply, Gas and Electricity, 13 Park Row, for furnishing, delivering and laying water mains and appurtenances in Morningstar, Richmond, Old Stone and Amboy Roads, and in Bridge Ave., Borough of Richmond. Security required is $90,000.

Mont Alto, Pa.—Until 5 p. m., June 9, by Samuel G. Dixon, Commissioner of Health of the State of Pennsylvania, Harrisburg, for labor and materials necessary for the construction of a water works system for the Pennsylvania State South Mountain Sanatorium, near Mont Alto. The work includes a reinforced concrete reservoir of 300,000 gallons capacity, two concrete collecting wells of 40,000 and 7,500 gallons capacity, respectively, a pump house, two triplex pumps driven by 8 h.p. gasoline engines, 5,000 ft. of 6-in. cast-iron pipe lines, 4,000 ft. of 4-in. pipe lines, 10,000 ft. of 3-in. and 2-in. pipe lines, together with all appurtenances and connections to the existing water system.

Dallas, Tex.—Until June 1, by J. B. Winslett, City Secretary, for building new pumping station.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Chicago, Ill.—Grading, Retaining Wall.—Until 11 a. m., June 4, by Department Public Works, 225 City Hall, for grading and lowering sidewalks, lowering shade trees, building a concrete retaining wall from Sedgwick St. to a point 180 ft. east of the east line of Sedgwick St., to correspond to established grade on Belden Ave.

Frankfort, Ind.—Ditch.—Until 2 p. m., May 30, by William A. Robinson, Drainage Commissioner, for constructing ditch.

Kansas City, Mo.—Grading.—Until 3 p. m., June 1, by Park Commissioners, Frank P. Gossard, Secretary, for grading land in Swope Park for dam, lagoon and lake.

New York, N. Y.—Embankment.—Until 11 a. m., June 3, by Commissioner of Common Lands Fund of Late Town of Gravesend, at office of Mayor McClellan, City Hall, for regulating and grading to an elevation above mean high water the roadway of Shell Road, between Avenue X and Canal Ave., the work requiring 10,000 cu. yds. of embankment. Plans with the Chief Engineer of the Board of Estimate and Apportionment, Room 1408, No. 277 Broadway, New York

Salt Lake City, Utah.—Excavation.—Until 2 p. m., June 2, by State Board of Land Commissioners, City and County Bldg., for irrigation work as follows: Excavation for approach cut rock, 20 cu. yds.; excavation for approach cut loose rock, 1,685 cu. yds.; excavation for approach cut earth, 190 cu. yds.; excavation for tunnel, 420 lin. ft.; excavation for outlet cut rock, 155 cu. yds.; excavation for outlet cut loose rock, 790 cu. yds.; excavation for outlet cut earth, 1,010 cu yds.; rip rap for outlet cut 150 sq. yds.

Woods Cross, Utah.—Water Channel.—Until May 28, by Deseret Live Stock Co. of Woods Cross, Utah. for the construction of about 16,000 ft. of water channel in Skull Valley, Tooele County, which channel is to be lined with cemented masonry. A bid is also wanted on only one mile of this channel constructed in the same way. Profile and specifications may be had from James H. Moyle, Deseret National Bank Bldg., Salt Lake City, or from R. E. Caldwell, No. 208 Sharon Bldg., Salt Lake City.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Los Angeles, Cal.—Aqueduct.—Until July 17, by Board of Public Works, Horace B. Ferris, Secretary, for the construction of the Jawbone Division of the Los Angeles Aqueduct, with a capacity of four hundred second feet, including about 43,000 lin. ft. of lined tunnel, 60,000 lin. ft. of lined conduit, and 340,000 cu. yds. of excavation. The work is subdivided into three sections, and separate or lump sum proposals will be received.

Chicago, Ill.—Laying Cable.—Until 11 a. m., June 2, by William Carroll, City Electrician, 12 City Hall, for dredging a trench across the Calumet River at 106th St., and placing a cable therein, etc.

Chicago, Ill.—Coal Hopper.—Until 11 a. m., June 2, by Department Public Works, 322 City Hall, for alterations and additions to coal hopper at Jackson Park Ave. pumping station.

Carrollton, Miss.—Electric Plant. — Until June 16, according to reports, by Mayor and Board of Aldermen, for rebuilding municipal electric light plant.

Brooklyn, N. Y.—Fencing.—Until 11 a. m., June 3, by Bird S. Coler, Borough President, for fencing vacant lots on the south side of 31st St., the work including 2,312 lin. ft. of fencing.

Portland, Ore.—Light House.—Until noon, Aug. 14, by Light House Engineer, Portland, for material and erection of Hinchinbrook Entrance Light Station, Alaska.

Philadelphia, Pa.—Fencing.—Until May 29, by Fairmount Park Board, J. T. Vodges, Superintendent, on fencing.

Spokane, Wash.—Walls.—See under Bids Asked -Bridges.

St. Andrews, Man.—Dam, Etc.—Until 4:30 p. m., July 8, by Fred Gelinas, Secretary Department Public Works, Ottawa, Ont., for the construction of movable dam, steel service and highway bridge, repair shop, etc., at St. Andrews Rapids, Red River, Province of Manitoba. Plans, etc., at Ottawa, at the offices of Mr. A. R. Dufresne, Resident Engineer of the Department at Winnipeg; Mr. J. G. Sing, Resident Engineer, Confederation Life Bldg., Toronto; Mr. C. Desjardins, Clerk of Works, Postoffice, Montreal, and Mr. Ph. Beland, Clerk of Works, Postoffice, Quebec.

Materials, Machines, Supplies, Tools, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Pipe. — Until noon, June 6, by the District Commissioners, District Bldg., for furnishing cast iron water pipe.

Minidoka, Idaho.—Electrical Apparatus.—Until June 19, by U. S. Reclamation Service, Federal Bldg., Chicago, Ill., for furnishing electrical apparatus for use in connection with power and pumping development at Minidoka Dam, Minidoka Irrigation Project, Idaho.

New Orleans, La.—Rock.—Until 11 a. m., June 6, by Maj. J. F. McIndoe, U. S. Engrs., 1539 Louisiana Ave., for furnishing about 10,000 tons of rock at points on Mississippi River below Vicksburg, Miss.

Carson City, Nev.—Pipe.—Until June 6, by State Board of Capitol Commissioners, for furnishing 5,000 ft. of 8-in. converse or Mathenson lock joint pipe, f. o. b., Carson City, Nev.

Irvington, N. J.—Crushed Stone.—Until June 2, by M. Stockman, Town Clerk, for furnishing and delivering 1,000 tons of crushed mountain stone.

Brooklyn, N. Y.—Pipe, Tools, Etc.—Until 2 p. m., June 10, by John H. O'Brien, Commissioner Water Supply, Gas and Electricity, 13 Park Row, New York, for furnishing and delivering the following: (1) stop cock boxes and covers, security required $10,000; (2) tools, garden implements, etc., security $2,000; (3) pipe, pipe fittings, valves, boiler tubes, etc.; (4) supplies for pumping stations, reservoirs and repair yards; (5) miscellaneous machine tools and machines.

New York, N. Y.—Box Cars.—Until 2 p. m., June 2, by F. C. Nordsiek, Assistant Purchasing Agent, Panama R. R., 24 State St., for furnishing 300 box cars.

New York, N. Y.—Traveling Cranes.—Until 2 p. m., June 10, by John H. O'Brien, Commissioner Water Supply, Gas and Electricity, 13 Park Row, for furnishing, delivering and installing one hand-operated traveling crane in the high-pressure pumping station located at Gansevoort and West Sts., and furnishing, delivering and installing one hand-operated traveling crane in the high-pressure pumping station located at Oliver and South Sts., Borough of Manhattan.

New York, N. Y.—Broken Stone.—Until 11 a. m., June 1, by Lawrence Gresser, President Queens Borough, 5th St. and Jackson Ave., Long Island City, for furnishing and delivering 5,000 cu. yds. of broken stone of limestone, ¾ in.; 400 cu. yds. of limestone screenings; 1,000 cu. yds. of broken stone of limestone, 1½ in.; 2,925 cu. yds. of trap rock screenings; 6,475 cu. yds. of broken stone of trap rock, 1½ in.; 2,100 cu. yds. of broken stone of trap rock, ¾ in.

New York, N. Y.—Pipe, Lumber, Etc.—Until 10 a. m., June 2, by Bureau Supplies and Accounts, Navy Department, Washington, D. C., to furnish at the navy yard, New York, N. Y., a quantity of naval supplies, among which are the following: Sch. 1220: Iron pipe and fittings, valves, file cabinets.—Sch. 1226: Bolts, screws, hack-saw blades, hardware and tools.—Sch. 1227: Lumber.—Sch. 1228: Sheet brass.—Sch. 1230: Bolts and nuts, bronze, crucibles.—Sch. 1236: Repairing quarters.—Sch. 1249: Lighting wire.—Sch. 1250: Steel.—Sch. 1251: Machine screws, etc.—Sch. 1252: Steel.—Sch. 1254: Shrinking drill.—Sch. 1255: Steel.

Rome, N. Y.—Pipe, Specials.—Until noon, June 10, by Water and Sewer Commissioners, Ray Armstrong, Clerk, for furnishing about 3,745 net tons of cast iron water pipe and 12 net tons of specials. Knight & Hopkins, Engineers, Rome. Official advertisement will be found elsewhere in this issue.

Youngstown, O.—Pipe, Valves, Etc.—Until June 1, by Board Public Service, for furnishing pipe, valves, hydrants, etc., for new water mains in Wick Ave. and East Federal St.

Edmond, Okla.—Water Works Material.—Until noon, June 15, by City Clerk, for purchase by the city of material and machinery necessary in the construction of a complete system of waterworks, and will include two 125-HP. tubular boilers, two duplex steam pumps, one straight line air compressor, one feed water heater, two boiler feed pumps, 25 fire hydrants, 15 water gate valves and about 250 tons of cast iron pipe.

CONTRACTS LET.

The following contracts have been let recently:

Denver, Colo.—Bridge.—Pueblo Bridge Co., at $4,200, for constructing 80 ft. bridge over Arkansas River at Browns Canon.

New Haven, Conn.—Paving.—C. W. Blakeslee & Sons, for macadamizing, as follows: White St., $1,392; St. Ronan St., $8,851; Winthrop Ave., $5,296. Frank Brazos, for macadamizing Webster St., $4,005; Newhall St., $2,645; Division St., $3,685; Rosette St., $2,892.

Atlanta, Ga.—Pump House, Etc.—Griffin Construction Co., at $29,330, for building foundations and house for new pump at Hemphill Station.

Savannah, Ga.—Bridge.—Austin Bros., Atlanta, Ga., at $3,245, for constructing steel draw bridge over Great Ogeechee River at King's Ferry.

Rathdrum, Idaho. — Bridge. — Carscallen Bros., Coeur d'Alene, Idaho, at $7,450, for constructing steel bridge over Coeur d'Alene River at Lane.

Chicago, Ill.—Concrete Work.—Turner Construction Co., 11 Broadway, New York, has been awarded a contract for considerable reconstruction work in reinforced concrete for the Murphy Varnish Co. in their factory at Chicago.

Peoria, Ill.—Bridge —William Noonen, Tremont, Ill., at $2,348, for steel and concrete bridge over Sugar Creek in Hittle Township.

Sterling, Ill.—Bridge.—Clinton Bridge & Iron Works, at $3,580, for an iron bridge over Rock River at Prophetstown.

Princeton, Ill.—Bridge.—Joliet Bridge & Iron Works, at $2,255, for erecting two bridges for county.

Fort Wayne, Ind. — Bridge. — National Bridge Co., Indianapolis, Ind., at $26,750, for reinforced concrete bridge over St. Mary's River on Clinton St.

Frankfort, Ind.—Road.—John Adams, Lebanon, Ind., at $1.695, for constructing gravel road.

Fort Wayne, Ind.—Culverts.—County Commissioners have awarded contracts for 41 small concrete arches and culverts to George Jaap, William Goodfellow and David C. Purman.

Indianapolis, Ind.—Sewer.—American Construction Co., Daniel Foley, President, at $4.92 per foot, for constructing 29,500 ft. of East Michigan St. sewer. Bids for work were opened last summer, but award of contract has been held up by court proceedings.

Indianapolis, Ind.—Bridge.—H. F. Hackedorn & Co., at $3,425, for constructing bridge over Lick Creek, southeast of city.

South Bend, Ind.—Pipe Sewer.—H. De Vos & Co., for pipe sewer in Olive St.

New Albany, Ind.—Paving.—W. O. Sweeney, Jefferson, Ind., for paving West Main St. with vitrified brick.

Warsaw, Ind. -- Ditch. — Emanuel Gick, North Manchester, at $3,985, for constructing three-mile ditch in Paw Paw Township.

Springfield, Mass.—Bridge Work.—Casper Ranger, Springfield, for erecting bridge at Jackson St. for N. Y., N. H. & H. R. R.

South Bend, Ind.—Bridge Work.—Contracts have been awarded by the County Commissioners of St. Joseph County as follows: To Caton & Olmsted, Galesburg, Ill., one 14 ft. concrete arch, one 36 ft. steel bridge and new wing wall to a 25 ft. arch; to Van Shyhawk & Hitch, Marion, Ind., five concrete arches ranging from 5 ft. to 16 ft. span.

Minneapolis, Minn.—Railroad Grading.—Smith & Jones, Duluth, Minn., for clearing, grading and grubbing 30 miles of northern right-of-way of the Twin City & Lake Superior Ry. near Foxboro.

Billings, Mont.—Bridge.—Security Bridge Co., Minneapolis, Minn., at $19,750, for constructing new bridge over Yellowstone River at Columbus for the county.

Brooklyn, N. Y.—Warehouse.—Turner Construction Co., 11 Broadway, New York, for constructing the new warehouse for Fred'k Loeser & Co. at Schemerhorn and Livingston Sts., Brooklyn. Building will be 170 ft. by 140 ft. in plan, eight stories, basement and sub-basement, as well as roof and pent houses. Reinforced concrete will be used throughout, excepting only the Livingston St. front, which will be brick with terra cotta trim. Work will be begun at once. Wm. Higginson, Architect.

Charlotte, N. C.—Bridge.—Canton Bridge Co., Canton, O., at $1,500, for steel bridge on Derita Road for County.

Binghamton, N. Y.—Sewers.—John J. Tyne, for following sewers: Beethoven St., $371; Wales Ave., $827; Moffatt Ave., $1,333. A. L. Willey, for Judson St. sewer at $1,272.

Youngstown, O.—Sewer.—Anthony O'Hora, at $1,900, for sewer in Dewey Ave.

Wormleysburg, Pa.—Bridge, Etc.—Hatfield & Hyde Co., West Fairview, for construction of section of state road and new bridge near Wormleysburg.

Reading, Pa.—Bridge.—L. H. Focht & Son, Reading, at $19,550, for reinforced concrete bridge of four 75 ft. arches, to be erected at Dauberville for the County.

Kittanning, Pa.—Road Work.—P. F. McCann, Greensburg, Pa., at $43,549, for improvement of Garrets Run road in Monon Township, Armstrong County; H. C. K. Hinkle, Altoona, Pa., at $40,446, for reconstruction of road in South Buffalo Township.

Cameron, Tex.—Bridge.—C. Q. Horton, Austin, Tex., at $1,250, for building iron bridge at Waco Crossing on Elm Creek.

Galveston, Tex.—Road Work.—County Commissioners have awarded following contracts for road work: Suderman-Dolson Co., paving 9¼ miles of Deepwater and LaPorte Road with mud shell at $54,978, and paving five miles of Washington County Road with shell at $30,693. W. S. Hipp, at $20,828, for laying crushed rock on West Montgomery Road, and at $20,828 for constructing 2½ miles of shell pavement on Houston and Crosby County Road. Same bidder was also awarded contract at $37,490 for constructing crushed rock pavement on West Montgomery Road, and at $23,219, for a similar pavement on Houston and Pierce Junction Road.

Wenatchee, Wash.—Bridge Approach.—J. J. O'Connor, at $2,230, for building bridge approach.

Green Bay, Wis.—Paving.—McGrath Construction Co., at $8,998, for macadamizing on Webster Ave., and at $4,663 for similar work on North Broadway.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States.

Gadsden, Ala.—Louisville & Nashville R. R., E. E. Kuersteiner, Bridge Engineer, Louisville, Ky., has decided to erect a new bridge over Coosa River. The bridge will be a steel structure about 600 ft. long.

Fresno, Cal.—County Supervisors have been asked to construct a $10,000 bridge over Kings River in Reedley.

Denver, Colo.—State Engineer's Department has completed plans for bridge in Park County, and a bridge in Chaffee County, and bids will be asked soon.

Pueblo, Colo.—Following bids were received May 11, for the reconstruction of the burned section of the C St. viaduct: Wichita Construction Co., $16,000; Pueblo Bridge Co., $15,685; M. F Levey Construction Co., Denver, $15,900; Alexander Campbell, $17,150.

Mason City, Ia.—County Supervisors have ordered plans for four concrete arch bridges for the county. The bridges will cost $11,620, and are as follows: Geneseo Township, $4,115; Pleasant Valley, $2,800; Bath, $2,780; Lake, $1,92[illegible]

Wichita, Kan.—City Engineer is preparing estimates of cost for two foot bridges on 15th St., and for a foot bridge over the Little Arkansas River on Buffoon Ave.

Lawrence, Kan.—County Commissioners have decided to erect three new bridges over the Big Wakarusa and one bridge over the Little Wakarusa.

Shreveport, La.—City Engineer has completed plans for a bridge at Madison Ave.; estimated cost is $20,000.

Marquette, Mich.—County Engineer Carpenter is preparing plans and estimates for the contemplated new bridge across the Sturgeon River to be built as a part of the extension of the Dickinson County road east of Loretto.

St. Paul, Minn.—City Engineer L. W. Rundlett has prepared a sketch for a steel bridge over the Earl St. crossing of the Northern Pacific and Omaha tracks.

St. Louis, Mo.—Brennehe & Fay, Fullerton Bldg., St. Louis, have been selected by Andrew J. O'Reilly, President Board Public Improvements, to draw the plans for the Municipal Free Bridge and to supervise its construction.

Newark, N. J.—County Freeholders rejected all bids received May 11, for constructing bridge on Glenn Ave., Millburn, and have directed County Engineer Drum to draw new plans for a steel beam structure.

Trenton, N. J.—Plans prepared by County Engineer Eppele for a combination steel and concrete bridge over a stream crossing the Scotch road near the Ewing Station, have been approved.

Whitesboro, N. Y.—Town is asking that Legislature pass bill allowing construction of a bridge over Oriskany Creek, to replace washed away structure. Estimated cost is $7,000. Isaac P. Bielby is a member of the Town Board.

Akron, O.—County Commissioners will award contracts for repairing about 50 bridges.

Canton, O.—Massillon Board of Trade has asked County Commissioners to construct single span bridge over Tuscarawas River on West Tremont St., Massillon.

Cleveland, O.—A. B. Lea, County Engineer, has been directed to draw up specifications for the construction of the new Rocky River bridge on Detroit Ave., Rocky River. The bridge will cost about $266,000.

Hamilton, O.—City Council will at once take up matter of erecting new bridge over C. H. & D. R. R. tracks at G St.

Youngstown, O.—North Side Improvement Association has been organized with Joseph Murphy as Secretary, and is advocating the construction of an overhead bridge from the foot of Belmont Ave., across the tracks and landing on Decker St., with an approach from Commerce St.

Atoka, Okla.—County Commissioners have voted to build three bridges: One across Gaines Creek to cost $5,000, one across Brushy Creek to cost $4,000, and the other across Boggy Creek four miles west of Kiowa, to cost $4,000. Joseph Tanneyhill is County Commissioner.

Pittsburg, Pa.—Ordinance is before City Council directing that the question of expending $1,000,000 for the purchase of the Allegheny River bridges be submitted to the people.

Brownsville, Tex.—U. S. House of Representatives has passed bill authorizing St. Louis, Brownsville & Mexico R. R., J. N. Miller, General Manager, Kingsville, Tex., to build a bridge over the Rio Grande River at this city.

Houston, Tex.—City Council has been petitioned to construct a bridge over Buffalo Bayou at Main St.

Ogden, Utah.—Following bids were received May 18, by A. F. Parker, City Engineer, for the construction of a reinforced concrete arch of 65 ft. span across the Ogden River: Jorgensen Bros., 420 Kearney St., San Francisco, Cal., $7,550; Midland Bridge Co. (Box 1055), Salt Lake City, $5,875; M. F. Levy Construction Co. (Symes Bldg.), Denver, Colo., $5,085; Pueblo Bridge Co., Pueblo, Colo., $4,979; Wm. Doyle, Contractor, 3232 Washington Ave., Ogden, Utah, $4,742. The contract will probably be awarded to the lowest bidder.

Norfolk, Va.—An appropriation of $8,000 has been made for the building of a concrete bridge in Jackson Park and connecting Lovitt Ave. with Holt St.

Toronto, Ont.—A by-law will probably be submitted to the rate payers at the January election to raise $270,000 for a viaduct to connect Wellesley St. and Danforth Road.

Railroads

Items Arranged Alphabetically by States.

Brookings, Ark.—Brookings & Peach Orchard R. R. Co. have been chartered and proposes to build a 3-mile road from Brookins' spur, near Knobel, on the main line of the Iron Mountain. Capital stock is $6,000. Henry Quellmotz is President of the company.

Greeley, Colo.—Advices from this city state that F. O. Olsen is promoting a project for the construction of a railroad from Kersey to Hudson, connecting the Union Pacific and Burlington Roads at those points. The construction of a line from Kersey to this city is also included.

Manitou, Colo.—Boston parties, according to reports from Denver, are to construct a three-mile scenic railroad from Manitou to Crystal Park. At the latter place it is proposed to spend $500,000 for constructing an artificial lake, buildings and pavilions. The railroad will cost about $500,000 and the company proposes to expend another $500,000 in general improvements at Manitou.

Atlantic, Ia.—Atlantic Northern & Southern Ry., H. S. Pattenberg, Atlantic, Vice President, is stated to have awarded contract for promotion work and surveys for the proposed north and south extensions of the road.

Hibbing, Minn.—Duluth, Misabe & Northern Ry. has surveys underway for a probable extension from this place south to the Coleraine Branch. Several surveys have been made, all of them passing through the Western Addition and to Tivoli, 25 miles distant from Hibbing. H. L. Dresser, Duluth, Minn., is Chief Engineer.

Frederick, Md.—Washington, Frederick & Gettysburg Ry. Co., D. Columbus Kemp, President, Frederick, was to let a contract about May 25 for the extension of its line from Lewiston, Ind., to the Monocacy Valley R. R. The work included 12,000 cu. yds. excavation and 75,000 ft. B. M. of trestling.

Dexter, N. Y.—Dexter & Eastern R. R. has applied to Public Utilities Commission for permission to build a railroad from this village to Dexter Junction between the Brownsville and Limerick. The company, which has a capital stock of $20,000, also desires to issue bonds for $75,000. The Dexter & Eastern is controlled by the Dexter Sulphite, Pulp & Paper Co., Dr. Clarence W. Campbell, Superintendent of the company, being President of the railroad.

Lincoln, N. Dak.—Construction of a farmers' railroad from this place to Harvey, 39 miles, is under consideration, and a bonus of $30,000 has already been promised. Fred Bentz, Lincoln, is interested.

New York, N. Y.—The East River Terminal R. R. Co. has asked permission of the Public Service Commission to build and operate a freight shifting railroad on dock property in Williamsburg, Brooklyn. The proposed road is to extend from Kent Ave. and North Fourth St. to Wythe Ave., near North Third St.

Baker City, Ore.—It is stated that work is to be resumed shortly on the construction of the railroad from this city to Eagle Valley. Seven miles of the roadbed have been graded. A. W. Jacobs is Engineer in charge.

Mangum, Okla.—Local press reports state that the Colorado, Texas & Mexico Ry. is ready to lay 100 miles of track between Mangum, Okla., and Chillicothe, Tex., including the Hollis branch.

Shawnee, Okla.—Local Chamber of Commerce has started a movement to raise a bonus of $200,000 to be used in building a railroad from here to Checotah.

Philadelphia, Pa.—Delaware, Lackawanna & Western R. R., according to advices from this city, will open bids about June 5, for building a 28-mile cut-off, to cost $12,000,000. Lincoln Bush, Hoboken, N. J., is Chief Engineer D., L. & W. R. R.

Pittsburg, Pa.—Final surveys are now under way for the New York-Pittsburg Air Line R. R., which is being promoted by Joseph Ramsey, Jr., former President of the Wabash R. R.

Ochiltree, Tex.—Residents of Ochiltree County are preparing to build a railroad east and west from this place and have already subscribed $70,000 for the project. Dr. George F. Perry, Ochiltree, is interested.

Port Arthur, Tex.—Sabine Valley R. R., now being built from Marshall, Tex., to Hemphill, may be extended to this city. L. E. Walker, Marshall, is Manager.

Quanah, Tex.—The Stockholders of the Farmers & Merchants' R. R. of this city have ordered a survey made between Quanah and Wellington, via Hollis, Okla.

Tacoma, Wash.—It is reported here that the Northern Pacific Ry. is preparing to begin work on the $3,000,000 Point Defiance water-grade route out of Tacoma to Portland. A. R. Cook, Tacoma, is Division Engineer.

Sheridan, Wyo.—Colorado & Southern Ry., H. W. Cowan, Chief Engineer, Denver, Colo., is considering building an extension to Sheridan, passing through Buffalo and Douglas.

Groveton, Tex.—Texas Northern Ry. Co. has been incorporated; principal office is to be at this city and capital stock is $50,000. The company proposes to construct a railroad from Groveton to Lufkin, about 36 miles. The incorporators are: Wm. T. Joyce, Chicago; D. J. Batchelder, St. Louis; R. C. Hitchcock, L. P. Atmar and J. C. Anderson, Groveton; P. A. McCarthy, W. S. Trout, Lufkin; H. M. Garwood, Edwin B. Parker and C. R. Wharton, Houston.

Hereford, Tex.—Colorado, Hereford & Gulf R. R. Co., with capital stock of $420,000, and principal office at this place, has been incorporated and proposes to build a railway from a point on the northern line of Dallam County in a southerly and southeasterly direction through the counties of Dallam, Hartley, Oldham and Deaf Smith, to the town of Hereford, and thence in a southeasterly direction through the counties of Deaf Smith, Castro, Lamb, Hartley, Terry, Gaines, Dawson, Martin, Midland, Glasscock, Sterling and Iron, to San Angelo, Tex. Total length of proposed road is 420 miles. The incorporators are: A. D. Goodenough, George W. Irwin, Jr., C. W. Dodson, T. E. Shirley, John P. Slaton, W. M. Knight, W. D. Beach, G. A. Parker, C. G. Witherspoon, L. Gough, J. D. Thompson, C. F. Kerr and J. L. Fuqus, all of Hereford.

Dunnville, Ont.—Toronto, Hamilton & Buffalo Ry., E. Fisher, Chief Engineer, Hamilton, Ont., according to advices from this place, is to construct the Dunnville, Wellandport & Beamsville Ry. between Dunnville and St. Anns, where a connection will be made with the first named road.

Electric Railways.

Items Arranged Alphabetically by States.

Anniston, Ala.—Alabama Railway & Electric Co. has been chartered and proposes to construct an electric railway from a point near Anniston in Calhoun County to a point near Dothan in Houston County. The capital stock is $200,000.

Fayetteville, Ark.—Fayetteville Land Co. and the Northwest Construction Co., of Minneapolis, Minn., are considering building an interurban railway between points in Washington, Benton and Madison Counties. Benton County has already agreed to furnish the right-of-way for the line and Washington County will be asked to do the same.

Colfax, Ia.—James Donahue, Davenport, Ia., has secured franchise and right-of-way for an electric car line from this city to Hotel Colfax, one mile distant.

Des Moines, Ia.—Des Moines & Sioux City R. R. Co. has been incorporated, and proposes the construction of an electric railway between the cities named. The offices of the company are to be located at Lake City, Ia., and surveys for the line have already been commenced from that point. A. O. Anderson, C. E., Lake City, Ia., is Secretary.

Red Oak, Ia.—Red Oak & Northeastern Interurban Co. has been incorporated and proposes to build an electric railway from Red Oak to Des Moines, passing through the towns of Grant, Greenfield, Stuart, Redfield and Adel. B. B. Clark of Red Oak is President; G. W. Curtis, Vice President; M. N. Spencer, Secretary, and L. D. Goodrich, Treasurer.

Spirit Lake, Ia.—Right of way is stated to have been secured for the proposed interurban line from Spirit Lake to Sioux City. J. D. Browning, Spirit Lake, is interested.

East St. Louis, Ill.—With principal office in this city and nominal capital stock of $150,000, the Wood River, East Alton & Bunker Hill Traction Co. has been incorporated and proposes to construct an electric railroad from Wood River, Madison County, Illinois, to Gillespie, Macoupin County, paralleling the Cleveland, Cincinnati, Chicago & St. Louis R. R. The incorporators and first board of directors are: J. T. W. Rudesill, R. W. Smith, S. B. Knepper, and B. A. Campbell of East St. Louis, and D. R. Maxey of Wood River.

Indianapolis, Ind.—Indianapolis, Cloverdale & Terre Haute Traction Co., formed some time ago, has secured complete right of way for the road between Mooresville and Cloverdale. It is intended to commence construction this summer on the portion of the road from Mooresville to Monrovia and Hall. E. M. Bowman is interested.

Fort Wayne, Ind.—The Federal Construction Co. has been organized to build an electric railway from Fort Wayne to South Bend, taking up the project abandoned some time ago. Perry Randall, Fort Wayne, is interested.

Ottawa Beach, Mich. — Toledo, Ottawa Beach & Northern Ry. is to be extended to Detroit, according to reports.

Minneapolis, Minn.—A company has been formed here to build an interurban line from this city to Medicine Lake, Minn. Right of way for the first six miles of the line has been secured and is said to be ready for grading. The tentative route for the first 40 miles is to Wayzata, Long Lake, Stubbs Bay and Winsted. The Minnesota Construction Co., John Blichfeldt, President, has had charge of the preliminary work.

Ava, Mo.—J. B. Quigley, Sedalia, Mo., is promoting project for the construction of an electric railway from this place to Cedar Gap.

Springfield, Mo.—Construction of an electric railway from this city to Nixa is under consideration. W. H. Schrieber is reported to be interested.

Greenport, N. Y.—Estimates of cost are now being made for a car line in this village, connecting with Orient Point. Right of way has been secured in Greenport, East Marion and Orient. Wallace H. Halsey is Engineer. Frank Vail, Greenport, is interested.

Condon, Ore.—Wasco County Electric & Power Co. has effected its organization, and proposes to build an electric railway from Condon southwest to Antelope, Madras and Bend, with branches to Howard and Dayville. Power plants will be built on the Deschutes and John Day River. Capital stock of the company is $3,000,000. George S. Carpenter, Fossil, Ore., is President, and F. T. Hurlburt, Condon, Ore., is Treasurer.

Pittston, Pa.—Pittston & Avoca Street Railway Co. is to ask Borough Council of Hughestown for an extension of its franchise for one year. The company was granted a franchise last June to operate a street railway on Parsonage St. from one end of the borough to the other.

York City, Pa.—York Railways Co. is considering building a line from the Country Club to Richland Ave.

Sewers.

Items Arranged Alphabetically by States.

Auburn, Ala.—A $17,000 sewer system is to be constructed for the Alabama Polytechnic Institute. Prof. E. M. Mitcham is in charge of the work.

Little Rock, Ark.—City is considering installation of a storm sewer system for the business district. System could be installed for about $500,000. E. A. Kingsley is City Engineer.

Elmhurst, Cal.—Proposition to bond sanitary district for $75,000 for sewer purposes was voted down at recent election.

Selma, Cal.—City has voted $50,000 of bonds for sewer construction.

Willows, Cal.—Town Clerk has been directed to communicate with engineers in Redding, San Francisco and Palo Alto with a view to securing estimates on installing sewer system

Fitzgerald, Ga.—City will vote May 24 on issuance of $130,000 of bonds for constructing sewer system.

Perry, Ia.—Plans are under way for improvement of city sewer system.

Larned, Kan.—City Council is working on plans for sewer district No. 2.

Stafford, Kan.—Town is considering installing sewer system to cost about $20,000, according to estimates of Prof. Hoad of the University of Kansas. Septic tank system of disposal is proposed.

Topeka, Kan.—Petitions are being circulated asking for construction of sewer in 2nd Ward, east of Santa Fe tracks. John Rogers is City Engineer.

Dayton, Ky.—Ordinances have been passed for the construction of vitrified brick or concrete sewers along McKinney and Vine Sts.

Lawrence, Mass.—City Council has passed ordinance for special loan of $80,000 for work on Osgood St. sewer and paving Common St. Ordinances are before Council appropriating $15,000 for continuance of Ward 1 sewer and $20,000 for a sewer in Fairmount Park.

Taunton, Mass.—Ordinance is before City Council providing for construction of lateral sewers in several streets.

Boyne, Mich.—City has voted to issue $20,000 of bonds for sewer and street improvement work.

Kalamazoo, Mich.—City Engineer Johnson has prepared plans for extension of sewer on Fulford St. Sewer will be 2,500 ft. long and 3 ft. in diameter, and material for it will be purchased by city.

Caldwell, N. J.—A sewage disposal plant to cost about $60,000 is to be constructed for this place.

Hightstown, N. J.—Borough proposes to construct sewer system.

Jamestown, N. Y.—Council has approved expenditure of $42,000 for sewer extensions.

Mount Morris, N. Y.—Installation of a sewer system to cost $110,000 is proposed. M. D. Baker is Engineer.

Oswego, N. Y.—Construction of a sewer system in the East Side is under consideration. Estimated that sewer can be built for $45,000.

Mount Vernon, O.—Board Public Service is considering constructing sewage disposal plant.

Reading, Pa.—Bill is before City Council providing for an election to vote on $600,000 loan to construct sewers, pave streets and erect a new city hall.

Ridley Park, Pa.—Councils have decided to have plans and specifications prepared for extending the Stony Creek outfall sewer to tidewater, and have directed that a general scheme for sewage disposal plant be worked out. St. George H. Cooke, Cambridge Bldg., Chester, Pa., is Borough Engineer.

Park City (P. O., Knoxville), Tenn.—This place has voted to issue $25,000 of bonds for sewers.

Houston, Tex.—North End Improvement Club, J. D. Rook, President, is advocating construction of complete sanitary sewer system for the 5th Ward.

Portsmouth, Va.—Construction of sewers in 5th Ward and additions to present sewage pumping station is proposed at a cost of $110,000. J. Davis Reed is Mayor.

Roanoke, Va.—Issuance of $100,000 of bonds for sewer construction is under consideration.

West Rutland, Vt.—State Board of Health has recommended that this village take early steps for installing sewer system.

Bellingham, Wash.—City Engineer Troutman has estimated the cost of constructing a sewer outlet at $35,897.

Plymouth, Wis.—Plans for a sewer system for this city have been made. C. W. Starrett is President Board Public Works.

CONTENTS OF MAY 20, ISSUE OF ENGINEERING-CONTRACTING.

EDITORIAL:

The Importance of the Caption of an Advertisement and How to Prepare Attractive Captions 303
How Can I Get Started in Contracting With Small Capital 303

CONCRETE SECTION:

Safe Design and Construction of Reinforced Concrete Chimneys 304

EARTH AND ROCK SECTION:

The Cost of Maintaining Horses in New York City 309
A Machine for Digging Trenches or Canals 310
Drilling Blast Holes With a Rod Drill 310

GENERAL SECTION:

Letters to the Editors: Some Criticisms of Dredging by Contract and an Answer 311
Data On Street Dust 313
Results of Tar and Oil Road Treatment Experiments Made at Jackson, Tenn., in 1905 314
PERSONALS 314

STREET IMPROVEMENTS.

Cambridge City, Ind.

The Town of Cambridge City, Ind., will receive bids until June 9th, 7:30 p. m., for the following street improvements:

1,500 lineal feet of 4-foot cement sidewalk.

2,200 lineal feet of 5-foot cement sidewalk.

2,500 lineal feet of cement curb and gutter.

2,000 lineal feet of resetting stone curb and placing new cement gutter.

Placing storm sewer under Main St., and grading street.

Plans and specifications can be seen at the office of the Town Clerk, Cambridge City, Ind., or at the office of CHAS. BROSSMANN, Consulting Engineer, Union Trust Bldg., Indianapolis, Indiana. 22-1t

ELECTRICAL AND PUMPING MACHINERY.

—ALGIERS SEWERAGE STATION "C"—Office of the Sewerage and Water Board, 602-604 Carondelet street, New Orleans, La., April 14th, 1908.

Sealed proposals will be received until 3 o'clock p. m., Tuesday, June 30th, 1908, for furnishing and erecting the following machinery:

2—100 K. W. 250 volt, direct current generators.

2—75 H. P. 250 volt motors.

1—2,500,000 gallon turbine pump, to work against a 125 foot head, directly connected to an electric motor.

1—1,000,000 gallon triplex pump, to work against a 125 foot head, geared to an electric motor.

1—2,000,000 gallon centrifugal pump unit, to work against a 20 foot head.

2—4,000,000 gallon centrifugal pump units, to work against a 20 foot head.

2—5 H. P. 250 volt motors.

1—Surface condenser, capable of condensing 6,500 pounds of steam per hour; together with air pump.

Also all exhaust and water piping, valves, wiring, switchboard, lights, and other appurtenances, completely erected.

Specifications with blank form of proposals may be obtained at the office of the Board. Plans will only be furnished upon personal application.

A certified check on a New Orleans bank, in the sum of $1,000, deposited in accordance with the terms of the specifications, will be required of each bidder.

A surety company bond in an amount equal to 25 per cent. of the gross amount of the contract, with a surety company doing business in the State of Louisiana and acceptable to the Sewerage and Water Board, will be required of the successful bidder.

The right is reserved to reject all bids

F. S. SHIELDS,
Secretary.

GEO. G. EARL,
General Superintendent. 17-10t

VIADUCT.

Spokane, Wash.

Sealed proposals will be received by the Board of Public Works until 2 o'clock p. m., June 10th, 1908, for furnishing materials and the construction of a permanent improvement, 785 feet long, on Sprague avenue, from the west line of Ivory street to a point 785 feet westerly therefrom.

Improvement contemplates one of four plans, as follows:

(1). A steel girder viaduct supported on tower bents.

(2). A reinforced concrete viaduct.

(3). Reinforced concrete retaining walls with earth or rock fill.

(4). Dry retaining walls with rock fill.

The bids must be complete for the whole work and must be made in duplicate, one copy addressed to the Mayor of Spokane, and one copy addressed to the Board of Public Works; each envelope to be titled with its contents, and the copy addressed to the Board of Public Works must contain a certified check upon a Spokane bank, made payable to the said Board of Public Works, in an amount equal to not less than ten per cent of the amount of the bid.

Plans and specifications may be seen or had at the office of the City Engineer of Spokane. The Board of Public Works reserves the right to reject any and all bids.

22-1t J. T. O'BRIEN, Secretary.

VITRIFIED BRICK PAVING, SEWERS, CURBING.

Belleville, Ill., May 21, 1908.

On June 3d, 1908, at 3 o'clock in the afternoon, the Board of Local Improvements of the City of Belleville, Ill., will open bids and on the same day award contracts for 60,000 square yards of vitrified brick street paving, including 20,000 feet of sewering and 40,000 lineal feet of curbing. The specifications are on file in the City Engineer's Office at the City Hall.

FRED J. KERN,
Mayor and Ex-officio President of the Board of Local Improvements. 22-1t

THE
NEW YORK CONTINENTAL JEWELL
FILTRATION COMPANY
FILTERS
General Contractors
CHICAGO NEW YORK

NATURE ADORNED
My booklet gives some interesting data on what may be accomplished in beautifying and improving the landscape. Engineers, city and railroad officials should send for it.
F. R. MEIER, 1 Broadway, NEW YORK
Consulting Forester

Contractors' Supplies and Heavy Hardware
Lead Furnaces
Jute Packing
Joint Runners
Calking Tools
All Kinds of Castings to Order
SCOVIL MFG. & SUPPLY CO., 639-641 Greenwich Street New York City

THE JOHNSON
Well Screen
All sizes. Brass. Large Capacity. Non-choking. Used everywhere.
WRITE FOR BOOKLET "EC."
E. E. JOHNSON, St. Paul, Minn.

Prompt Shipments
BEST EXTENSIBLE TRENCHING BRACE MADE
KALAMAZOO FDRY. & MACHINE CO, MICHIGAN
598 EAST MAIN ST.

A Concrete
built with two boards
by using the Dietrichs' Wall Form Clamps. The story is told in our BULLETIN E. Send for it.
THE DIETRICHS CLAMP CO.
15½ Kaufman Ave., LITTLE FERRY, N. J.

MISSISSIPPI RIVER COMMISSION, 1st and 2d Districts, U. S. Engineer Office, Room 20, Custom House, Memphis, Tenn., May 11, 1908. Sealed proposals, in duplicate, for about 205,000 cubic yards of levee work in Upper St. Francis Levee District will be received at this office until 12 o'clock, noon, June 10, 1908, and then publicly opened. Information furnished on application. WM. D. CONNOR, Capt. Engrs. 20-4t

The Center of Population

and the Point of Publication

OF

ENGINEERING-CONTRACTING

What This Means

TO YOU!

As a Subscriber, it means that the contract news in ENGINEERING-CONTRACTING reaches the average reader 48 hours fresher than it would be if our point of publication were in New York City. All contract news travels by mail from point of origin to point of publication. Since Chicago is close to the center of population, this means 24 hours for the average piece of contract news to reach New York. Then it travels back by mail—another 24 hours to reach the average reader. As a result, contractors in the Middle West, and West, and South, find it to their great advantage to subscribe for ENGINEERING-CONTRACTING, on this account alone; but there are other reasons, among which is the fact that ENGINEERING-CONTRACTING is the only **Methods and Cost** paper in the world, and this is the one class of information that is invaluable to every contractor and of vital interest to every person engaged in engineering construction.

As an Advertiser, the location of the point of publication of ENGINEERING-CONTRACTING in Chicago means that you will not be duplicating your advertising; for ENGINEERING-CONTRACTING is the only weekly newspaper in this field (civil engineering and contracting) published west of New York City. By the purchase of the weekly periodicals "Contract News" and "Engineering World" and by consolidating them with the ENGINEERING-CONTRACTING we produced a journal having a larger paid circulation than any western paper in the contracting or engineering field. But since that consolidation we have added nearly 5,000 new subscribers, and ENGINEERING-CONTRACTING is now read regularly (and in nearly every case the files are kept for permanent binding) **by more persons interested in engineering construction than read any other single periodical in the world.**

We cordially invite our advertisers to investigate the names on our subscription list, but persons advertising in this paper have a more convincing proof in the actual orders that they receive from ENGINEERING-CONTRACTING. An advertiser can no more tell the number of our subscribers by looking at the paper than he can tell the number of people he can reach with his telephone by looking at the receiver. For over two years we have made strenuous efforts to build up a large subscription list among the buying classes. Our success has been excelled only by the sale of Gillette's "Hand Book of Cost Data" of which we have sold 14,000 copies in 2½ years. Mr. Gillette is the managing editor of ENGINEERING-CONTRACTING which has therefore been called "A Serial Sequel of the Hand Book of Cost Data." For the same reason that the sales of the "Hand Book of Cost Data" have broken all records in the technical book world the number of subscriptions received for ENGINEERING-CONTRACTING during the past 2½ years have broken all records in the technical journal world.

All America is our field, but the West is our home. If you wish to reach the Western buyers in particular, ENGINEERING-CONTRACTING is, by all odds, the best advertising medium to use.

Engineering-Contracting
355 Dearborn St., Chicago

Edson Diaphram Trench Pumps

THE EDSON PUMP

was the FIRST **DIAPHRAGM PUMP** ever made. Experience counts for something. IT is the accepted STANDARD all over the world.

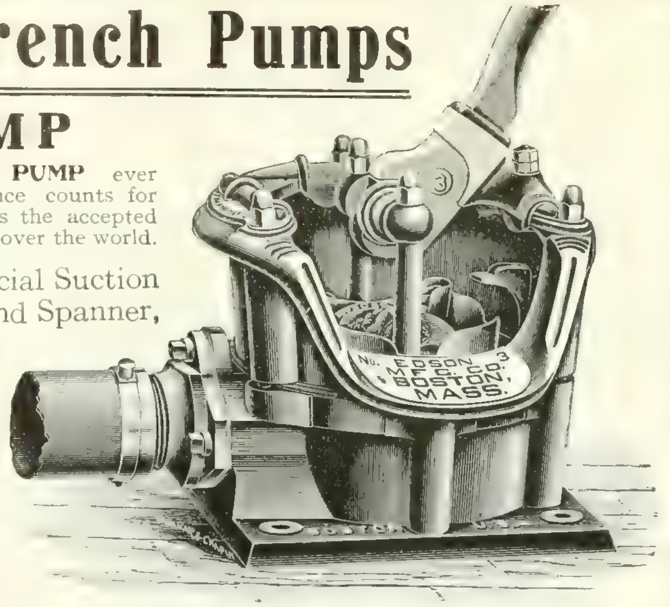
Complete Outfits, including Pump, Edson Special Suction Hose, Extra heavy Brass Couplings, Strainer and Spanner, **ready for business.** Extra lengths of **Suction Hose,** guaranteed **Diaphragms** and duplicate Pump parts, **carried in stock.**

SEND FOR DESCRIPTIVE CATALOG

Established 1859

EDSON MFG. CO.

256 Atlantic Avenue Boston, Mass.


No. 3
EDSON MFG. CO.
BOSTON, MASS.

225,000,000 - GALLON RESERVOIR AND DIVERSION SEWER.

Baltimore City Water Department,
Baltimore, Md.

Sealed proposals indorsed "Proposal for High Service Reservoir Construction, Baltimore City Water Department," addressed to the Board of Awards of Baltimore City, will be received at the office of the City Register, City Hall, Baltimore, Md., until eleven o'clock a. m., Wednesday, June 10th, 1908, for the construction of a High Service Reservoir and Diversion Sewer in connection therewith.

An approximate estimate of quantities is given below.

Plans and specifications, proposal form, etc., may be obtained at the office of the Water Engineer, City Hall, Baltimore, Md., on depositing five dollars ($5.00), which will be refunded on return of same.

All proposals must be accompanied by a certified check of the bidder on a Clearing House bank as a guarantee of good faith; the amounts to be as follows:

Proposals covering Item No. 1 or Items Nos. 1 and 2, five thousand dollars ($5,000.00).

Proposals covering Item No. 2 only, five hundred dollars ($500.00).

On awarding the contract, their checks will be returned to the unsuccessful bidders.

The successful bidder will be required to give satisfactory bond, equal in amount to the contract price, for the faithful performance of the agreement.

Proposals are invited on either or both of the two items following, and the Board of Awards reserves the right to reject any or all bids.

Approximate quantities—Item No. 1:

Excavation from basin	687,000 cu. yds.
Excavation cut-off wall trench	22,000 cu. yds.
Rolled embankment	282,000 cu. yds.
Rolled or puddled clay in trench	9,000 cu. yds
Waste	400,000 cu. yds.
Reinforced concrete cut-off wall	2,000 cu. yds.
Top soil, spread, rolled, seeded.	75,000 sq. yds.
48″ reinforced concrete conduit	1,010 lin. ft.
Slope paving	23,000 sq. yds.
Gate house substructure.	
Gate vault.	

Item No. 2:

60″ and 69″ concrete diversion sewer	2,100 lin. ft.
18″ vitrified pipe drain	350 lin. ft.

ALFRED M. QUICK.
Approved: Water Engineer.
J. BARRY MAHOOL,
President Board of Awards. 21-2t

BRIDGE.

Iron Mountain, Mich., May 25, 1908.

Sealed proposals will be received by the Board of County Road Commissioners of Dickinson County, Iron Mountain, Mich., until 1 p. m., June 6th, 1908, for the construction of a 135 foot span, steel or reinforced concrete, sub- and superstructure, bridge over the Sturgeon River near Loretto, Mich.

The Commissioners reserve the right to reject any or all bids.

G. V. CARPENTER,
22-1t County Engineer.

CAST-IRON PIPE AND SPECIAL CASTINGS.

Rome, N. Y.

Sealed proposals will be received by the Board of Water and Sewer Commissioners of the City of Rome, N. Y., until 12 o'clock noon, on the 10th day of June, 1908, for the furnishing of about 3,745 net tons of cast-iron water pipe and about 12 net tons specials, as called for in the specifications.

Specifications can be obtained at the office of the Board, or from Knight & Hopkins, Engineers, Rome, N. Y.

The Board hereby reserves the right to reject any or all bids, or accept any that in their judgment will be for the best interest of the city.

A bond satisfactory to the Board in amount and sureties will be required of those to whom the contract may be awarded.

A certified check, made payable to the order of the Board of Water and Sewer Commissioners, Rome, N. Y., to the amount of $4,000.00 must be deposited by each bidder and accompany his bid as a guarantee that in case the contract is awarded him, he will, within seven days thereafter, execute such contract.

Bids must be sealed and addressed to the Board of Water and Sewer Commissioners, Rome, N. Y., and marked on the outside of the envelope enclosing them "Proposals."

BOARD OF WATER AND SEWER COMMISSIONERS,
HARVEY S BEDELL, Chairman
BARTON HASELTON.
H. W. BARNARD.
J. T. WIGGINS.
RAY ARMSTRONG, Clerk. 22-1t

MISSISSIPPI RIVER COMMISSION, 1st and 2d Districts, U. S. Engineer Office, Room 20, Custom House, Memphis, Tenn., May 16, 1908. Sealed proposals, in duplicate, for about 540,000 cubic yards of levee work in Upper and Lower St. Francis Levee Districts will be received at this office until 12 o'clock, noon, June 16, 1908, and then publicly opened. Information furnished on application. WM. D. CONNOR, Capt. Engrs. 21-4t

REINFORCED CONCRETE SEWER

Iron Mountain, Mich.

Sealed proposals will be received by the Board of Public Works at the office of the City Clerk of the City of Iron Mountain, Mich., up to 1 o'clock p. m., June 1st, 1908, for the construction and laying of a reinforced concrete sewer, 48 inches in inside diameter, length 2,896 feet.

Plans and specifications for the above may be seen at the office of the City Clerk of said city.

Each proposal must be accompanied with a certified check of $500.00, payable to the Chairman of the Board of Public Works, which will be returned upon the execution of the contract.

Proposals must be presented in a sealed envelope directed to the City Clerk and endorsed "Sewer Bids."

The right is reserved to reject any or all bids.

JOHN B. CALVI,
20-3t City Clerk.

FOR SALE

Contractors' Equipment

32 H. P. Portable Boiler
No. 0, No. 1, No. 2 Smith Mixers.
Single Drum and Double Drum Hoisting Engines.
¼-Yard Cube Mixers.
½-Yard Ransome Mixers.
All Round Wiener Dump Cars.

Description on Request.

Address, F. S. ROBINSON, 701 Owen Bldg., Detroit, Mich.

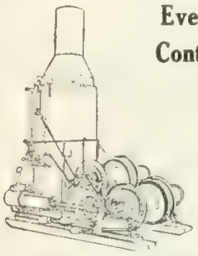
ESTABLISHED 1820
YOUNG & SONS
MANUFACTURERS OF
ENGINEERING MINING AND SURVEYING INSTRUMENTS
PHILADELPHIA

In a Hurry?—Send to Hough

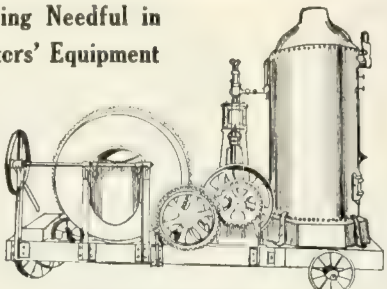
EXPEDITION FOR CONTRACTORS

in the completion of work is made possible by our ability to ship from our big new warehouse

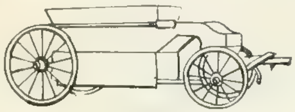
Everything Needful in Contractors' Equipment



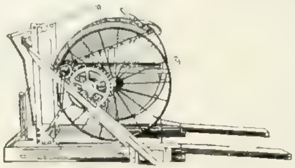
Buffalo Hoisting Engines



Ransome Concrete Mixers

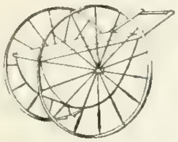


Troy Wagons

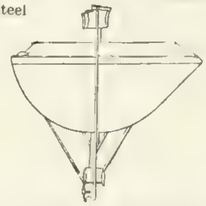


Street and Sidewalk Concrete Mixers

M-B Cold Twisted Steel

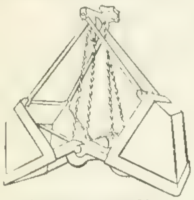


Ransome Concrete Carts

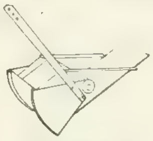


Automatic Dump Concrete Hoist Buckets

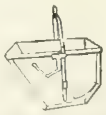
Swivel Concrete Cars



Hercules Clam Shell Buckets



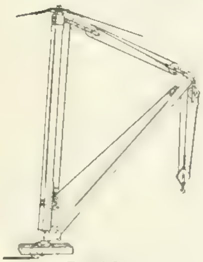
Sand, Stone and Concrete Bin Gates



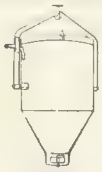
Self-righting Buckets

Hercules Orange Peel Buckets

Balanced Cableway Cranes

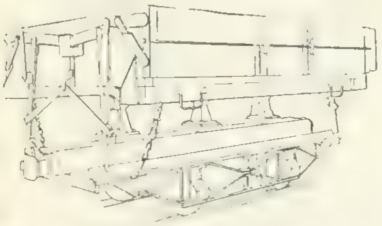


Derricks

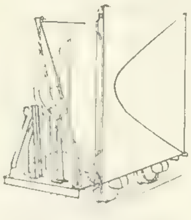


Bottom Discharge Concrete Buckets

Charging Barrows



Peteler Two-way Dump Cars



Two-way Side-Dump Concrete Cars

These cuts illustrate only a part of our complete line.

We are furnishing plants for every conceivable contractors' purpose. Probably we can suggest a better way of doing your work.

Our machinery is built to stand up under severe service. It is **always on the job doing the work.**

Why not finish your job on time—and at a profit. We can help you do it.

Write or wire us your requirements.

William B. Hough Company
Monadnock Block
CHICAGO U. S. A.

Telephone Main [illegible]
ESTABLISHED 1863
R. SEELIG & SON
MANUFACTURERS OF
ENGINEERING, MINING AND SURVEYING
INSTRUMENTS
170 EAST MADISON STREET
Chicago

May 15, 1908.

Engineering-Contracting,
Chicago.

Gentlemen:—

Our advertisement in Engineering-Contracting has just brought us a good-sized order for our instruments.

We receive a large number of inquiries from your paper and are pleased to recommend it as an advertising medium.

Very truly yours,

R. Seelig & Son

Western Contractors Can Be Reached

more effectively by a proposal advertisement in ENGINEERING-CONTRACTING than in any other periodical. Why? ENGINEERING-CONTRACTING is the only weekly civil engineering and contracting journal published west of New York City. Naturally our Contract News reaches the contractors of the Middle West and West about 48 hours fresher than if it were published in New York City. It takes Chicago news 24 hours to travel to New York and 24 hours to return; and, as Chicago is the center of population of the United States, it follows that the *average* contract news in ENGINEERING-CONTRACTING reaches the *average* contractor 48 hours fresher than it could if published in New York. ENGINEERING-CONTRACTING, by virtue of its prompt news service and by virtue of its articles on Methods and Costs, has more contracting firms on its subscription list than any other periodical in America. The results that our advertisers are getting clearly prove this statement. Hence it is a great mistake not to advertise all proposals in ENGINEERING-CONTRACTING, particularly if it is desired to reach contractors in the Middle West and West. In speaking of the large number of contractors who mentioned ENGINEERING-CONTRACTING when answering a proposal ad., Mr. Hershey S. Welch, City Engineer of North Platt, Neb., says: "You must certainly get results for your advertisers."

ENGINEERING-CONTRACTING
355 Dearborn Street CHICAGO

Why Buy An Outfit? We Will Rent You One

Does lack of plant deter you from bidding on some attractive job in your vicinity--some job in which you can see money if you only had the plant to handle it? Our business is to supply this plant on lease. We own over a million dollars' worth of general and special contractors' plant for you to draw from. Any part of this plant will be rented to you at a price per cubic yard, per day, per month or per year. This price, moreover, will be such that you can make money on the contract, and you can pay our rental out of your monthly estimates. You invest no capital in plant and have no idle plant on your hands when the work is done. Do you know of a simpler method of financing a construction job? Our offer is as wide open to the small contractor as it is to the large one. WRITE, WIRE OR CALL.

UNITED STATES EQUIPMENT COMPANY
FISHER BUILDING, CHICAGO

WHAT'S THE USE

putting up with old style wooden cars, scrapers, etc., that are slow, unwieldy and expensive to operate when

YOU CAN RENT

a Koppel Portable Railway and Equipment either by the month or contract on reasonable terms?

You can do twice the work in half the time and at half the cost if you use Koppel equipment.

WRITE FOR RENTING LIST E.

ARTHUR KOPPEL COMPANY

NEW YORK
139 Morris Bldg.

CHICAGO
341D Monadnock Bldg.

BOSTON
53 Oliver St.

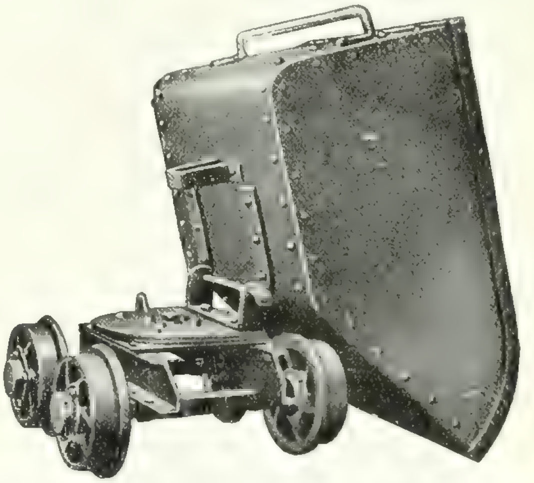
PITTSBURGH
1610 Machesney Bldg.

SAN FRANCISCO
1511a Chronicle Bldg.

BALTIMORE
449 Equitable Bldg.

Contractors'
Rotary Dump Concrete Car

This is only one of our specialties. We manufacture CARS for Concrete, Gravel, Sand, Stone, Brick. Also all kinds of ELEVATOR BUCKETS,



ELEVATORS, REVOLVING SCREENS, BOTTOM DUMP BUCKETS, WHEELBARROWS and CONCRETE CARTS.

If you need any of the above write us for prices and CATALOG EC No. 10; we can quote you the lowest and give A No. 1 goods.

H. B. SACKETT SCREEN & CHUTE CO.
4214-4228 State Street, CHICAGO

WANTS

Undisplayed Cards under this heading cost only

One Cent a Word

Displayed $1.00 an Inch.

TECHNICAL MEN superintendents, engineers and draftsmen. Openings in all parts of the world at the highest possible salaries. Write us today of your experience. Hapgoods, 305 Broadway, New York City, or Suite 1012 Hartford Building, Chicago.

WANTED One small second-hand hoisting machine with double drum, all to be in good repair. Stone & Green, 1361 Monadnock Bldg., Chicago

WANTED Position -Tunnel superintendent with complete organization. Soft ground, rock or compressed air. Open for engagement June 1. Address "Tunnel Supt.," care Engineering-Contracting, 13-21 Park Row, New York. 21-2t

WANTED—Young man, technical graduate, experienced in concrete construction, desires position in designing, estimating, etc., for contractor, or consulting engineer. Address Box 30, care Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Position as superintendent or foreman of concrete construction. Several years' experience. Middle or Southern States preferred, but will go anywhere. Address Box 111, Jackson, Tenn 22 1t

WANTED—Position as assistant to contractor, or as general foreman. Am civil engineer, 32 years of age, with 12 years' experience in railroad, sewer, road, concrete and masonry construction. Address "T S.," 3716 Ellis Ave., Chicago, Ill.

WANTED—Position as foreman on bridge or building work after June 5. Fifteen years' experience bridges, foundations, factory buildings and reinforced concrete bridge work. Address Box 36, care Engineering-Contracting, 355 Dearborn St., Chicago, Ill. 22-4t

WANTED—Position as Mechanical Draftsman by young engineer with 4 years' experience. Willing to commence with moderate salary where opportunity to learn and advance is offered. Address Box 37, care Engineering-Contracting, 355 Dearborn St., Chicago. 22-2t

WANTED—Position.—By young engineer with two years' experience in general field work and drafting. Good draftsman and instrument man. Position desired offering permanency of location. Assistant in city preferred. Address Box 35, care Engineering-Contracting, 355 Dearborn St., Chicago. 21-6t

WANTED—Position as construction engineer or contractor's superintendent, by graduate civil engineer 28 years old. Five years' experience on design and erection of structures of steel and reinforced concrete. Best of references. Address Box 34, care Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Will pay 15 cents each for one perfect copy of Engineering-Contracting for each of the following dates: July 3, 1907; July 10, 1907; August 7, 1907. These papers are wanted to complete files for binding. All reading pages must therefore be in perfect condition. Address "P. V. C.," care Engineering-Contracting, 355 Dearborn St., Chicago. 21-tf

---

Wanted to Buy

THEW STEAM SHOVEL

Address Box 32, care of Engineering-Contracting, Chicago, stating price and giving size of shovel

---

J. F. GRAHAM

(Roadmaster Graham)

RAILROAD LABOR AGENT

All classes of Laborers in Any Number

SUPPLIED FREE

Competent Foremen a Specialty.
Services Guaranteed Satisfactory.

WRITE OR WIRE

204 Washington Avenue South
MINNEAPOLIS, MINN.

FOR SALE

1 Kearns **Revolving Excavator,** 1½ yard Orange-Peel Bucket, 65 ft. boom.

Two 36″ gauge **Saddle Tank Locomotives,** 12 ton.

One 15 ton, 36″ gauge **Saddle Tank Locomotive.**

New light rails and standard section **relayers** of all weights.

BLOCK-POLLAK IRON CO.,
Chicago Cincinnati St. Louis
Yards, East Chicago, Indiana

FOR SALE

Five-ton Northern, standard gauge, full circle

LOCOMOTIVE CRANE

with 25 ft. boom, now being rebuilt at Chicago shops and arranged to handle small clam or orange peel.

Ready about April 15th.
Will be good as new.

WILLIS SHAW
171 La Salle Street, Chicago

HOISTING ENGINES

JUST COMPLETED, TESTED AND READY FOR SHIPMENT

3 No. 9 20-H.P. double cylinders 7x10 in., double drum 14x26 in., with boilers
2 No. 10 30-H.P. double cylinders 8½x10 in., double drum 14x28 in., with boilers
2 No. 13 20-H.P. double cylinders 7x10 in., double drum 14x26 in., without boilers
1 No. 14 30-H.P. double cylinders 8½x10 in., double drum 14x28 in., without boilers
1 No. 20 50-H.P. double cylinders 10x12 in., triple drum 16x32 in., with boilers

In order to realize cash quickly the above engines are offered at a large reduction from the regular price

J. M. STONER, Jr., Receiver

PITTSBURG INDUSTRIAL IRON WORKS

Penn Ave. and 29th St. PITTSBURG, PA.

STUDY OUR

CONCRETE

COURSES

Reinforced Concrete Design; Concrete Construction and Contracting, Plain and Reinforced; Manufacture of Cement Products, i. e. Blocks, Brick, Etc.

THESE courses are all meritorious. The latter teaches a new and scientific method of making concrete blocks, that gives as low as 4 per cent absorption and remarkable strength. Such blocks will win the favor of engineers; the cost is practically no higher. FREE CATALOG explains. Please indicate the course you are interested in.

CONCRETE ENGINEERING
584 Caxton Bldg., Cleveland

CONTRACTORS AND ENGINEERS

SAVE LABOR

USE

Nash's Expeditious Measurer

A book of 200 pages of indexed tables, showing at a glance the cubic contents of any stone or package according to its length, breadth and depth. Used by Contractors, Quarrymen and Engineers everywhere. Order of your bookseller or the publisher. **$2.00 Postpaid.**

A. L. NASH
17 State Street NEW YORK
Send for Sample Pages

SAVE TIME

AVOID ERRORS

FOR SALE OR RENT

Two Vulcan **shovels,** 1½ yard and 2½ yard, 3 sets engines.

Two 42″ gauge saddle tank 9 x 14, **locomotives,** saddle tank.

Two 36″ gauge **locomotives,** saddle tank, 9 x 14.

30 and 56 lb. **relayers** with plates.

Traction engines, hoisting engines, pumps, etc.

HARPER MACHINERY COMPANY
1861 Fulton Bldg., Hudson Terminals,
50 Church Street, New York
Yards and Shops, Bloomfield N. J.

FOR SALE

1 Carson **Trench Machine.** Fine condition. Cost new $3,000.00. Will sell for.................. **$1,700**

1 ¾-yd. Smith **Mixer** on trucks, with engine.

10 1-yd. K. & J. **Scrapers.** Fine shape.

2 1½-yd. Oliver rotary **Cars.** Cheap.

1 8-wheel **Locomotive,** just overhauled and in fine condition. Price..... **$2,000**

Write us for anything you may be needing in the line of Contractors' equipment.

R. G. LUCAS & CO.
MARION, OHIO.

The Cincinnati Frog & Switch Co.

CINCINNATI, OHIO

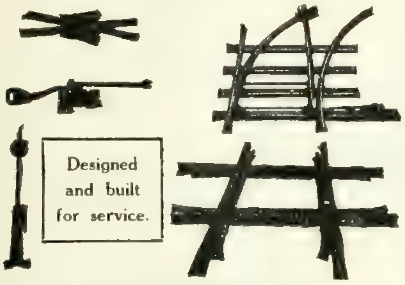
Manufacturers of

Frogs, Crossings, Switches, Switch Stands, Rail Braces,

And special track work of every description for Railroads, Mines, Mills, Contractors, Plantations.

FROGS, SWITCHES, CROSSINGS

Stands and Portable Track for all weights of rail for Quarries, Mines, Coal Tipples, Industrial Plants and Contractors' use.


Designed and built for service.

Catalogue and prices upon request

THE INDIANAPOLIS SWITCH & FROG CO.

SPRINGFIELD, OHIO

RARE BARGAINS in RAILS and EQUIPMENT

WALTER A. "ZELNICKER" SUPPLY CO.

in ST. LOUIS

DO YOU RECEIVE OUR STOCK LISTS?

LOCOMOTIVES

Eight 9x14 saddle tank 36-inch gauge. Also lighter and heavier locomotives. Have 165 locomotives from 6 to 70 tons in stock in our shops.

Also STEAM SHOVELS

Southern Iron & Equipment Co.
ATLANTA, GA.

Largest Dealers in Rebuilt Equipment in United States

EAST WORKS
New Freight and Passenger Cars

WEST WORKS
Rebuilt Coaches, Cars and Engines

Hicks Locomotive & Car Works

General Offices
Chicago Heights, Illinois

Sales Dept.
Fisher Building, Chicago, Ill.

Eastern Representatives
Empire Steel & Equipment Co., 141 Broadway, New York.

Steam Shovels, Locomotives, Cars, Etc.

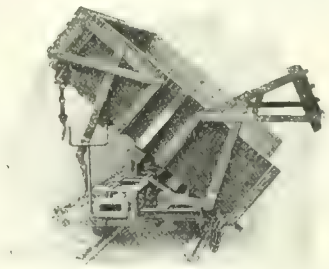
Contractors' and Railway Equipment

Telegraph, Telephone or Write Us.

A. C. TORBERT & CO.
547-548 Monadnock Block CHICAGO

VULCAN IRON WORKS
CHICAGO
PILE DRIVERS

"CONTINENTAL" DUMP CARS

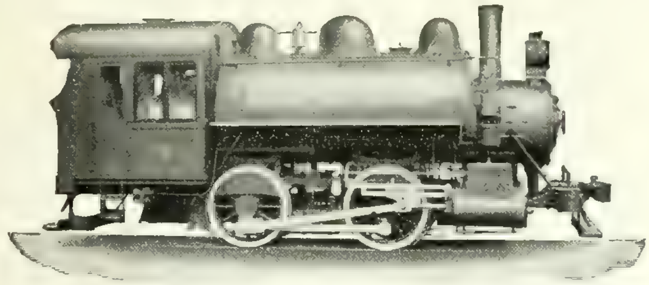


1½ to 20 Cubic Yards Capacity, any Gauge.

Continental Car & Equipment Co., (Inc.)

17 Battery Place, New York
Highland Park, Louisville, Ky.

LIGHT LOCOMOTIVES



For contractors, mines, plantations, industrial plants and light switching service generally.

Standard types in stock for immediate shipment. Any desired design built to suit purchasers' requirements.

Interchangeable spare parts always on hand.

AMERICAN LOCOMOTIVE COMPANY
30 Church Street, New York

Davenport Contractors' Locomotives

Excel in Hauling Capacity as well as in working and wearing qualities—That's why so many contractors use them exclusively

We build a contractor's locomotive—not merely a locomotive that can be used by contractors. This being our business, we have made it a point *to learn* by study and experiment the things that a contractor wants in a locomotive, and after learning, *to provide* these needed things in **Our Locomotive.** A contractor's locomotive has hard usage, and not the best care—good material and good workmanship are, therefore, essential, and we provide both. A contractor's locomotive must have hauling capacity—we guarantee **Davenport Locomotives** to haul more, size for size of cylinders, than any other. A contractor's locomotive has to be simple and easy to repair — **Davenport Locomotives** have interchangeable parts, and these parts are always kept in stock. We demonstrate all these claims in our CATALOG "EC." Send for it, and if you are ever in Davenport come and see our plant—we feel proud of it.

DAVENPORT LOCOMOTIVE WORKS, Davenport, Iowa

List of Contractors' Supplies.

If you wish the catalogs of the leading manufacturers of any tool or machine mentioned below, send us a postal card, giving your address and business, and the list number of article of which you want catalogs.

This will save you the trouble of writing several letters to different manufacturers. Should you later on have correspondence direct with the manufacturers, we shall apppreciate it if you will state in your letters that you are indebted to ENGINEERING-CONTRACTING for the introduction. Such a statement will be mutually beneficial.

2 Asbestos.
4 Asphalt.
6 Asphalt plants.
7 Asphalt tools.
8 Augers, pneumatic.

10 Ballast spreaders.
12 Balast unloaders.
14 Bearing, ball and roller.
16 Bearings, self-oiling.
18 Bellows.
20 Belt dressing.
22 Belting, canvas.
24 Belting, chain.
26 Belting, leather.
28 Belting, rubber.
30 Blacksmiths' tools.
31 Blasting batteries.
32 Block machines, cement and concrete.
33 Blocks, tackle.
Blowers. See 180.
36 Blue print machines.
38 Boilers.
39 Boiler covering.
40 Brakes, air.
42 Brick, building.
44 Brick, paving.
45 Brick machines.
46 Bridges.
48 Buckets, clam shell.
50 Buckets, dumping.
52 Buckets, orange peel.

60 Cableways.
62 Cars, ballast.
64 Cars, dump.
66 Cars, flat.
68 Cars, hand.
69 Cars, mining.
70 Carts. See also 520.
72 Carts, concrete.
73 Castings, brass.
74 Castings, iron.
76 Castings, steel.
Cement block mach. See 32
80 Cement pipe molds.
82 Cement walk tools.
84 Cement, natural.
86 Cement, Portland.
88 Chains, common.
90 Chains, sprocket.
91 Channelers.
92 Clocks, time.
93 Chimney construction.
94 Compressors, air.
95 Conduit, bituminous fiber.
Concrete reinf. See 474.
Conduit, vitrified. See 142.
96 Concrete fence post molds.
97 Computing machines.
98 Contractors' bonds.
100 Contractors' supplies.
102 Conveying machinery.
104 Cranes.
106 Cranes, locomotive.
108 Cranes, traveling.
110 Creosoting.
112 Crossings, railway.
114 Crushers, rock.
116 Culverts.

120 Derricks and fittings.
Draftmen's instrs. See 154.
124 Dredges.
126 Drill sharpeners.
Drills, air. See 136.
128 Drills, core.
130 Drills, diamond
132 Drills, pneumatic plug.
134 Drills, ratchet.
136 Drills, rock.
138 Drills, well.
140 Dynamite.
142 Ducts, vitrified.
Dump wagons. See 520.
144 Dynamos.

Electric motors. See 324.
152 Elevators, bucket.
154 Engineers' instruments.
156 Engines.
158 Engines, gas.
160 Engines, gasoline.
162 Engines, hoisting.
164 Engines, steam.
166 Engines, traction.
167 Expansion bolts.
168 Expanded metal.
169 Expanders, tube.
170 Exploders.
172 Explosives.

180 Fans or blowers.
182 Felt.
184 Fence and railing.
186 Filters, water.
187 Fireproof doors; partitions.
188 Flanges, steel.
190 Flue lining.
192 Flush tanks.
194 Forges, blacksmith.
195 Forms for concrete work.
196 Frogs.
198 Fuel economizers.
Fuse. See 170.

210 Garbage furnaces.
212 Gates and valves.
214 Gears and pinions.
216 Governors, engine.
218 Governors, water wheel.
220 Graders, elevating.
222 Gaskets.
224 Grubbers.

228 Hammers, pneumatic.
230 Hangers, joist.
232 Harness.
234 Hoists, air.
236 Hoists, chain, differential.
238 Hoists, electric.
240 Hoists, gasoline.
242 Hoists, horse-whim.
244 Hoists, steam.
246 Horse feed-bags.
248 Hose.
250 Hydrants.

260 Injectors.
261 Insulated wire.
262 Iron.
264 Iron, corrugated.
266 Iron, sheet.

270 Jacks, hydraulic.
272 Jacks, screw.
274 Jacks, track.
Jacks, trench. See 502.

280 Laborers supplied.
282 Lamp posts.
284 Lathe, metal.
286 Lights, contractors'.
288 Lime.
290 Locomotives, dinkey.
292 Locomotives, electric.
294 Locomotives, gasoline.
296 Locomotives, geared.
298 Locomotives, steam.
300 Lubricants.
302 Lumber, creosoted.

310 Machine tools.
312 Manganese steel.
314 Manhole covers.
315 Metaline.
316 Meters, water.
318 Mineral wool.
319 Mining machinery.
320 Mixers, concrete.
322 Motors, compressed air.
324 Motors, electric.
326 Motors, water.

330 Nickel steel.
332 Nuts and nut locks.

330 Oilless Bearings.

340 Packing.
341 Painting machines.
342 Paints.
344 Paving blocks, stone.
Paving bricks. See 44.
348 Picks.
350 Pile drivers.
352 Pile driver jets.
354 Piles, concrete.
356 Piles, interlocking, steel.
358 Piles, creosoted.
360 Pipe covering.
362 Pipe, cast iron.
364 Pipe, cement.
366 Pipe, lead.
368 Pipe, riveted steel.
370 Pipe, vitrified sewer.
372 Pipe, wrought iron.
374 Pipe cutting machine.
375 Pipe tapping machines.
376 Plows.
Plows, unloading. See 12.
Pneumatic tools. See 8, 132, 416.
380 Portable railways.
382 Powder, black.
383 Prism glass.
384 Pulleys.
386 Pumps, diaphragm.
388 Pumps, electric.
392 Pumps, sand.
394 Pumps, steam.
396 Pumps, trench.
398 Punches, hydraulic.
400 Quarry bars.

406 Railroad signals.
410 Rails, new.
412 Rails, second hand.
413 Railway track layers.
414 Rammers, pneumatic.
415 Recording instruments.
416 Riveters, pneumatic.
418 Road machinery.
Rock crushers. See 114.
422 Rollers, horse.
424 Rollers, steam.
425 Roofers' supplies.
426 Roofing.
427 Rope drive.
428 Rope, manila.
430 Rope, wire.

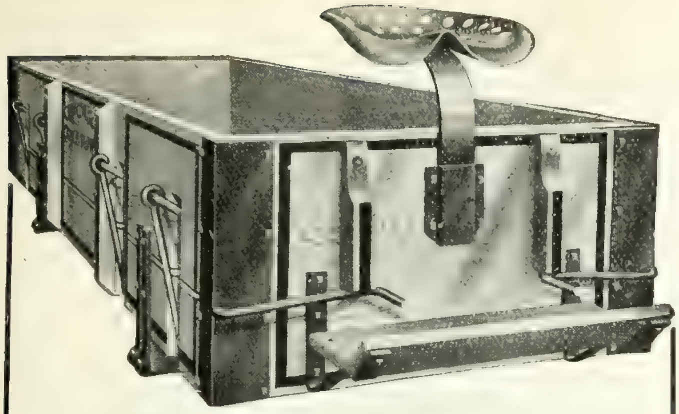
438 Sand blast apparatus.
Sand pump. See 392.
440 Saw mills, portable.
Scale box. See 462.
442 Scarifiers for macadam.
444 Scrapers, drag.
446 Scrapers, road.
Scrapers, wheel. See 528.
448 Screens, rotary.
450 Second hand outfits.
Sewer braces. See 502.
454 Sewer cleaners.
455 Sewer traps.
Sewer pipe. See pipe.
457 Shafting.
458 Sheaves.
460 Shovels, hand.
462 Skips.
464 Slate.
466 Sprinkling carts.
468 Standpipes.
470 Steam shovels.
472 Steel, structural.
474 Steel for reinf. concrete.
476 Stone, broken.
478 Stone dressing mach's.
479 Street sweepers.
480 Stump puller.
482 Switches.

490 Tanks, water.
491 Tapes, measuring.
Tapping mach's. See 375.
492 Tar.
494 Tents.
496 Ties, steel.
498 Tile.
Time keeping devices. See 92.
Traction engines. See 166.
Track laying mach. See 413.
499 Track tools.
500 Tracing cloth.
502 Trench braces.
504 Trench machines.
506 Turntables.

510 Valves, steam.
512 Valves, water.
513 Vault lights.
514 Ventilators.

520 Wagons, dump.
522 Waterproofing.
Well drills. See 138.
526 Wheelbarrows.
528 Wheel scrapers.
530 Windmills.
532 Wire cloth.
Wire rope. See 430.

The above is only a partial list of the headings in our Card Index. No matter what you want, TELL US and we will put you in prompt communication with the leading manufacturers, dealers or contractors.



This Is More Than a Portable Dumping Box

PORTABLE dumping boxes for wagons are common The Chicago Quick Dumper is more than a portable dumping box. It is a bottom dump wagon box which by means of a special device for operating the bottom doors distributes the load equally over the front and rear wheels and allows the gear to be coupled up as close as 65 inches. Every teamster knows what this means—it means light draft. The box is sand tight; it fits any wagon gear having a reach. Take off the box and the gear is ready for hauling lumber or poles or anything else that does not need a box. Put on the box and there is a high class dumping wagon at a quarter of the cost of any ordinary fixed box dumping wagon. Our CATALOG No. 22 tells all about the Chicago Quick Dumper. **Over 600 are in use in Chicago.**

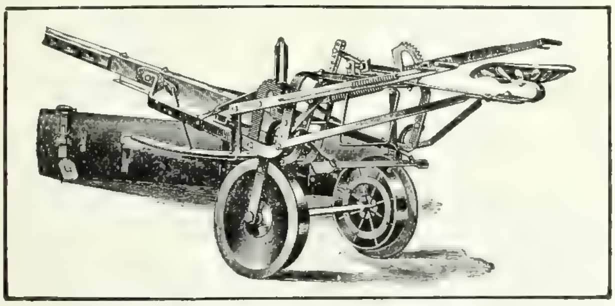
BLACK MANUFACTURING CO.

130 East Ohio Street CHICAGO

This One-Man Grader Saves a Third to a Half

REASONS are numerous why the 20th Century Grader is a horse-flesh saver, an economizer of time, a preventer of worry and anxiety—600 pounds is light for so strong a machine which takes the place, (in three-quarters of the instances) of the two-ton, clumsy grader. What's the use of killing your horses when one man and a team can do the work quicker and easier, without the horses tearing out their insides.

Our 1908 Model has several unique and noteworthy features found on no other grader. Among them; flanged wheels, lever side-adjustment for pitch of blade, adjustable shoes on mold-board, etc. These and a score of other good reasons why you should own and operate a



20th Century Grader

are told in our brand new booklet printed in orange and black, entitled, "20th Century Highways." This book tells how to make good roads out of bad ones, enumerates all the uses to which the 20th Century Grader can be put in constructing roads, railroad grades, irrigation ditches, for digging foundations for pavements, for leveling lawns, fields, etc., etc. It's valuable. Send now for it. It's free. Address

The Baker Manufacturing Co.

Dept. F, 706 Fisher Bldg. CHICAGO

American Society *of* Engineering-Contractors

Early last year, Halbert P. Gillette, Managing Editor of this journal, issued a call to contractors and engineers, asking them to join in forming an American Society of Engineering Contractors. Mr. Gillette agreed to act as chairman and secretary of the Society, *pro tem*, and in that capacity has already received over 900 applications for charter membership. The experimental stage is past, and a large membership of influential men is now assured. We urge every contractor and every engineer to join this great national organization. One of the main objects of the society is to secure uniform and equitable general clauses in engineering specifications. Another object is to combat the inefficient "day-labor system" of doing public work, and to educate the public to the true economy of doing all work by contract. A third object is to have a voice in the solving of all social problems affecting the welfare of contractors and engineers, such as the problems raised by labor unions. A fourth object is to exchange ideas on the management of men, the operation of machinery, the keeping of cost records, and such other business as would naturally come before a national organization of this character. If you have not already applied for membership, do so on the accompanying blank; and then urge your friends to join.

HALBERT P. GILLETTE,
Park Row Bldg., New York

DEAR SIR

I am desirous of becoming a charter member of the American Society of Engineering-Contractors, provided the dues and conditions of membership shall prove satisfactory to me when they shall be decided upon.

Name ....

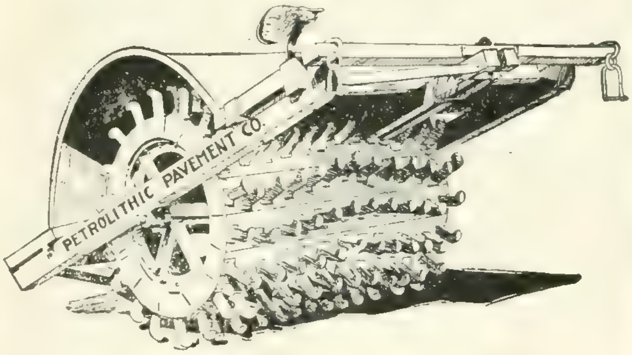
Occupation ....

....

....

Subgrades for Roads and Streets Made Dense as Hardpan

If all earth were hardpan, the thickness of concrete or macadam could be greatly decreased, yet the highway would retain a perfect surface, without settlements under traffic. This is self-evident. The Petrolithic Rolling Tamper does this very thing. It compacts any earth, **from the bottom up,** not from the top down, and pounds it into a mass as dense as hardpan. Earth weighing 90 lbs. per cubic foot in place has been compacted to 120 lbs. per cubic foot by this Rolling Tamper. You must first plow the ground to a depth of six inches, then roll it with the Petrolithic Rolling Tamper until its tampers no longer sink into the ground but ride upon the surface —that is the test of sufficient rolling.

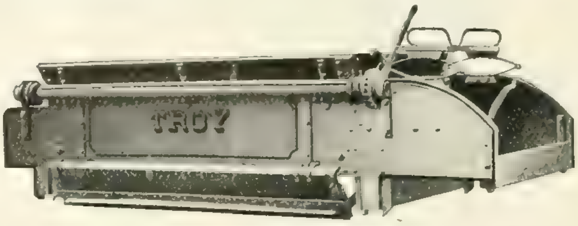

PETROLITHIC PAVEMENT CO.

You will then have a perfectly homogeneous subgrade, with no soft spots bridged over by the roller, and it will be as dense as hardpan. When the rolling first starts the tampers sink to the hilt, thus causing a compacting from the **bottom up.** This feature distinguishes the Petrolithic Rolling Tamper from every other form of roller. It is revolutionizing road and pavement building; for the natural soil, when properly compacted by a Rolling Tamper, itself performs the function of a concrete or macadam base, thus enabling the engineer to use much less concrete or macadam, or none at all. Write for our catalog.

Petrolithic Pavement Company

764 Pacific Electric Bldg., Los Angeles, Cal.

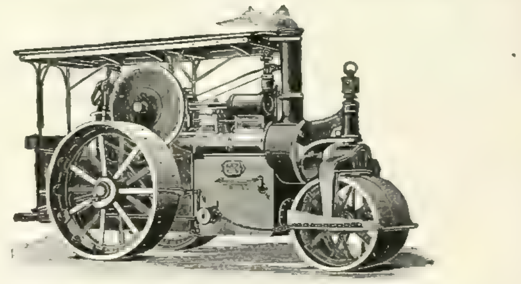
On general contract work it is always desirable to have some wagons from which the boxes may be removed. For example, if it is desired to haul large blocks or chunks of stone, a wagon box is not so good as a stone rack. So, too, if lumber is to be hauled, the box should be removed. Hence there will always be a field of usefulness for the ordinary "slat bottom wagon". But for every "slat bottom wagon" on the job there should also be a Troy Dump Box, for, by its use, such a wagon is converted into a dump wagon at a moment's notice. We ask you not to wait until you need a dump box, but to investigate now by sending for our BULLETIN E which explains in detail why the Troy Dump Box is to be preferred to any other, and why it will fit the gear of any wagon you may own or hire.



The Troy Wagon Works Co.

295 South Walnut Street TROY, OHIO

KELLY-SPRINGFIELD ROAD ROLLER CO.

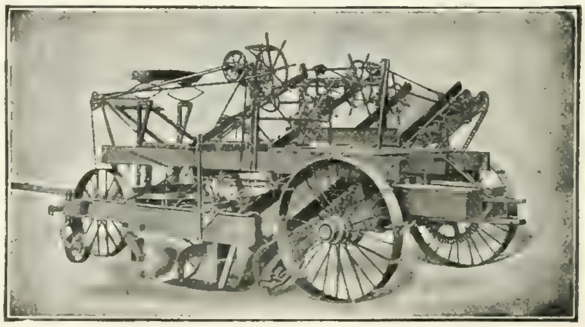


Steam Road Rollers, Over Eighteen Hundred in Use.
All Types, All Sizes, Satisfaction Guaranteed.
Send for Catalogue No. 4

SPRINGFIELD, O.

PHILADELPHIA OFFICE, 232 LAND TITLE BUILDING

NATIONAL ELEVATING GRADER



Send for Catalogue EC
INDIANA ROAD MACHINE COMPANY
FORT WAYNE, IND.

Some Advantages of

Creosoted Wood Paving Blocks

Smooth as Asphalt.

Durable as Granite Blocks.

Sanitary on Account of antiseptic treatment.

Noiseless to a greater extent than any other pavement.

Appeals to tax payers and contractors alike.

Capacity 3,000,000 yards a year.

Ayer & Lord Tie Company
1123—138 Washington Street
CHICAGO, ILL.

FRANK C. POWERS, Sales Agent

THE TRUTH ABOUT STREET PAVING

generally comes out **after** the pavement has been laid and when it is too late to remedy the mistake.

When Bitulithic is selected and laid no mistake is made. The truth about street paving is then so fully, clearly and convincingly laid bare that there is no longer room for doubt as to the ideal roadway.

Write For Illustrated Booklets

WARREN BROTHERS COMPANY
BOSTON, MASSACHUSETTS

"Bitulithic" Registered Trade Marks "Bitrock"
"Puritan" "Bituminous Macadam" "Bitustone"

GULF REFINING CO.

REFINER OF

Indian Territory and Texas Petroleum

MANUFACTURER OF

ASPHALT for PAVING and ROOFING

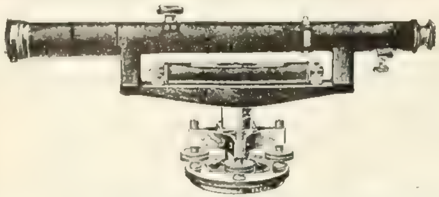
A Resurfaced Macadam Road after Oiling, at Delmar, N.Y.

WE MAKE A SPECIALTY OF

Heavy Oil of Asphaltum Base For Oiling Roads

Prompt shipments from Boston, New York, Philadelphia, New Orleans, Tampa, Fla., and Port Arthur, Texas.

General Offices: Frick Building Annex,
PITTSBURG, PENNSYLVANIA.



ENGINEER'S DUMPY LEVEL

FOR QUICK, ACCURATE WORK
FOR WORK ON ROUGH GROUND

A thoroughly reliable and accurate level of the finest workmanship. Erecting Telescope 18 inches, fine sensitive spirit level graduated on the glass, eyepiece adjustable vertically with patent Micrometer Focusing Arrangement with lock nut. Four Leveling Screws. Telescope bar and tube of spirit level cloth finish. The center is of the K & E Patent Construction. Split Tripod.

OUR COMPLETE CATALOG AND OUR SOLAR EPHEMERIS FOR 1908 (POCKET SIZE) FREE ON REQUEST.

127 Fulton Street, NEW YORK — **KEUFFEL & ESSER CO.,** — General Office and Factories HOBOKEN, N. J.
CHICAGO—ST. LOUIS—SAN FRANCISCO
Drawing Materials Mathematical and Surveying Instruments Measuring Tapes

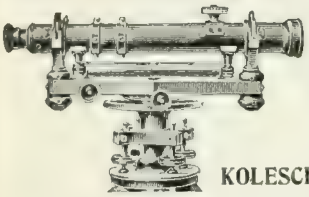
F. D. CROFOOT N. NIELSEN
Printing by Electric Light
Crofoot, Nielsen & Company
BLUE PRINTERS
Blue Printing, Black Printing Blue Line and Color Printing
Special Service Always—Speed and RESULTS. Big Floor Space and Equipment for Rush Orders.
167-169 E. Washington Street, CHICAGO
Phone 759 Main

BUFF SURVEYING INSTRUMENTS

The "Buff" is built by a family of experts who seek the continual advancement of the "Buff" reputation.

Send for Catalog No. 3

BUFF & BUFF COMPANY, Boston, Mass.



IS IT LEVEL?

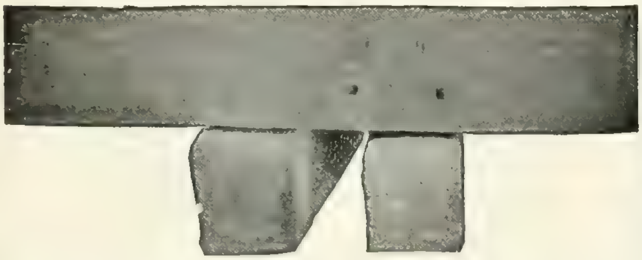
The use of an Architect's Level assures you of correct results and saves time. Our catalogue describes this and other useful instruments.

KOLESCH & CO., 142 Fulton St., New York

R. SEELIG & SON
172 E. MADISON ST., CHICAGO
MANUFACTURERS OF MOST IMPROVED
ENGINEERING and SURVEYING INSTRUMENTS
SEND FOR CATALOG NO. 6.

15 Mins. in Hot Paint Gives Life of 15 Yrs.

This photograph shows railroad ties of southern pine that were immersed 15 minutes in hot paint made by this company. After nine years service the ties are as sound as the day they were treated, which means that, at worst, they will have a life of not less than 15 years. The paint contains a germicide that is death not only to the fungus of rot but to teredos and all forms of timber parasites. No engineer who is concerned with the preservation of ties, piles, fences, telegraph and telephone poles, or bridge timbers, can offord not to send for our catalog at once and investigate this paint.



The Teredo-Proof Paint Company
17 Battery Place, New York

U. S. or CANADIAN PATENTS $25.00
We pay all expenses and disbursements except government fees.

Write to us for preliminary opinions on all legal matters. No charge unless retained.

Associates throughout Continental Europe, Great Britain, the Colonies, South America and Canada enable us to investigate and prosecute foreign interests with dispatch.

OUR PAMPHLET FOR THE ASKING.

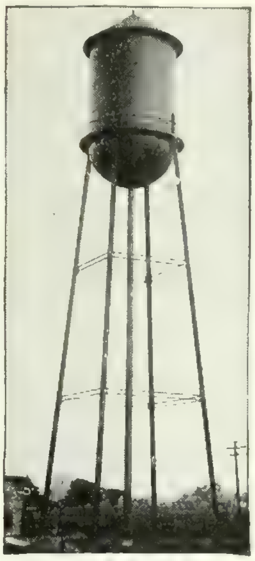
The Industrial Law League, Inc.
170 Broadway, New York City, N. Y.

One Way to Save Money

If you are interested in the construction or operation of municipal water works, you can save money for the city by constructing an elevated tank on the system. This will give a uniform static pressure of any amount desired upon the mains, and cause a saving in cost of pumping which will pay for the structure in a very short time, besides affording fire protection which is independent of the operation of pumps for several hours. These illustrations show some of the tanks we have built for this purpose. The cuts are all made to the same scale and give some idea of their comparative sizes, the Louisville tank being the largest in the world. Write for illustrated booklet.

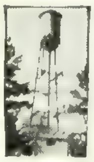
Chicago Bridge and Iron Works
Washington Heights Sta., Chicago.

Capacity 1,200,000 Gals.
Height 220 ft.
Louisville, Ky.
Louisville Water Co.



Capacity 200,000 Gals.
Height 157 ft.
Sycamore, Ill.
City Water Works

Cap'y 40,000 Gals.
Height 98 ft.
Greeley, Neb.
City Water Works



Cap'y 2,000 Gals.
Height 42 ft.
Belton, S. C.
Private Res.

Cap'y 60,000 Gals.
Height 85 ft.
Lock Haven, Ill.
C. P. & St. L. Ry.

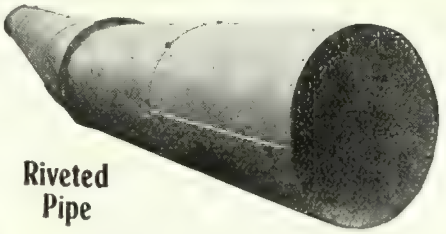
McWANE-LYNCHBURG
TRADE CAST IRON PIPE MARK
"QUALITY BEFORE QUANTITY"

WATER AND GAS WORKS MANAGERS

WRITE FOR CATALOG OF

McWANE PIPE WORKS
LYNCHBURG, VA. NEW YORK CITY

STEEL TANKS AND PLATE WORK



Riveted Pipe

We Construct **Steel Tanks** For Any Purpose

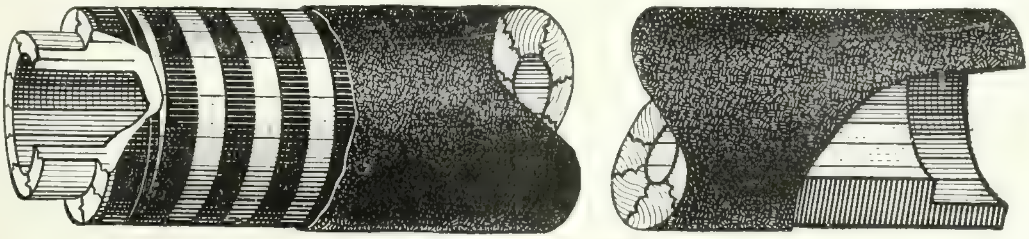
Modern Equipment Modern Methods
35 Years' Experience

WM. GRAVER TANK WORKS, EAST CHICAGO, IND.

Improved Combination Steel and Wood Pipe

For Municipal Water-Works Systems, Mines, Railroads, Chemical and Iron Works

Strength of Steel
Will Not Rust
Easily Installed



Durable
Cheaper Than Iron Pipe
Keeps Water Conveyed Sweet

Write For Circulars

THE MICHIGAN PIPE COMPANY, BAY CITY, MICHIGAN

CLASSIFIED DIRECTORY OF ADVERTISERS—(For location of advertisements see Alphabetical Index, page 8).

Air Compressors
American Well Works.
Ingersoll-Rand Co.

Architects' Supplies (See Engineers' Supplies, Instruments etc.)

Artesian Wells, Tools, Pumps
American Well Works.
Cook Well Co.
Feeley & Co., J. E.

Asphalt
Gulf Refining Co.
Standard Asphalt & Rubber Co.
Warren Bros. Co.

Automatic Stokers (See Grates, Traveling Link)

Ballast Unloaders and Spreader
Browning Engineering Co.
Marion Steam Shovel Co.

Bearings—Oilless and Self-Oiling
North Am. Metaline Co.

Blocks—Snatch and Tackle
Chisholm & Moore Mfg. Co.
Patterson Co., W. W.
Union Elevator & Machine Co.

Block Machines (See Concrete Block Machines)

Blue Print Apparatus and Paper
Am. Blue Print Paper Co.
Crofoot, Nielsen & Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.
Technical Supply Co.

Boilers
Graver Tank Wks., Wm

Bolts
Scovil Mfg. & Supply Co.

Bolts—Expansion, Toggle, Etc.
Cleveland City Forge & Iron Co.

Books
Audel & Co., Theo.
Clark Pub. Co., Myron C.
Nash, A. L.
Technical Supply Co.

Boots for Contractors
Rubberhide Co.

Borings, Test (See Artesian Wells)

Bridges, Roofs, Trusses, Etc.
Chicago Bridge & Iron Wks.
Continental Bridge Co.
Page & Shnable.
Ransome Concrete Machy. Co.

Buckets—Coal, Ore, Dredging
Channon Co., H.
Cyclopean Iron Works.
Hayward Co.
Hough Co., Wm. B.
Kiesler Co.
Northern Engineering Works.
Page & Shnable.
Sackett Screen & Chute Co.
Tide Water Iron Works.
Wiener Co., Ernst.
Williams Co., G. H.

Cableways — Suspension Wire Rope
Balanced Cable Crane Co.
Flory Mfg. Co., S.
Harper Machinery Co.

Car Couplers, Fenders, Fittings, Car Wheels
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Cars
Contin'tl Car & Equip't Co.
Harper Machinery Co.
Hicks Locomotive & Car Wks.
Hough Co., Wm. B.
Koppel Co., Arthur.
Peckham, Fred A.
Sackett Screen & Chute Co.
Weiner Co., Ernst.

Cars—Tanks
Graver Tank Wks., Wm.

Carts for Concrete, Etc.
Archer Iron Works.
Hough Co., Wm. B.
Ransome Concrete Machy. Co.
Sackett Screen & Chute Co.

Carts and Wagons — Ash and Dump
Contractors' Sup. & Equip. Co.
Good Roads Machinery Co.
Hough Co., Wm. B.
Indiana Road Machy. Co.
Ransome Concrete Mach. Co.
Sackett Screen & Chute Co.
Studebaker Bros. Mfg. Co.
Troy Wagon Works Co.

Castings and Forging
American Casting Co.
Green Engineering Co.
Scovil Mfg. & Supply Co.
Tide Water Iron Works.
Vulcan Iron Works.

Cement
Atlas Portland Cement Co.
Chicago Portland Cement Co.
Edison Portland Cement Co.
Lehigh Portland Cement Co.
Marquette Cement Mfg. Co.
Universal Portland Cement Co.

Chains
Hayden-Corbett Chain Co.
Woodhouse Chain Works.

Chain Belts—(See Power Transmission Machinery)

Chimney—Iron and Steel—(See Boilers

Clevis Nuts
Cleveland City Forge & Iron Co.

Clocks
Prentiss Clock Co.

Coal and Ore Handling and Conveying Machinery, Etc.
Browning Engineering Co.
Brown Hoisting Machy. Co.
Channon Co., H.
Hayward Co.
Hough Co., Wm. B.
Koppel Co., Arthur.
Northern Engineering Works.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Collapsible Centerings
Blaw Steel Centering Co.

Concrete Block Machines
Brandell Conc. Blk. Mach. Co.
Miles Mfg. Co., P. B.

Concrete Made Refractory
Stowell, E. R.

Concrete Mixers and Machinery—(See Mixers—Concrete)

Concrete Work—(See Contractors; also Fireproof Construction)

Consulting Forester
Meier, F. R.

Contractors
Caton & Olmstead.
Christman, Edward.
Concrete-Steel Retaining Wall Co.
Continental Bridge Co.
Gilbreth, Frank B.
Jackson, Inc., Geo. W.
McGrath, M. P.
Rodgers Co.
Trussed Concrete Steel Co.

Contractors' Supplies and Equipment — (See also Second-hand Supplies)
Archer Iron Works.
Channon Co., H.
Contractors' Sup. & Equip. Co.
Harper Machinery Co.
Hough Co., Wm. B.
Koppel Co., Arthur.
Lucas & Co., R. G.
Peckham, Fred A.
Sackett Screen & Chute Co.
Scovil Mfg. & Supply Co.
Shaw, Willis.
Torbert & Co., A. C.
Union Eltr. & Mach. Co.
Wiener Co., Ernst.

Converters and Cooling Towers
Graver Tank Works, Wm.

Conveyors and Conveying Machinery—(See Coal and Ore Handling and Conveying Machinery)

Correspondence Courses in Engineering
Concrete Engineering.

Couplings—Friction Clutch
Brown Hoisting Machy. Co.
Browning Engineering Co.
Sackett Screen & Chute Co.

Cranes
Brown Hoisting Machy. Co.
Browning Engineering Co.
Northern Engineering Works.

Crayons and Pencils—(See Engineers' Supplies)

Creosoting
Ayer & Lord Tie Co.

Crossings—Railways (See Frogs)

Crushers and Pulverizers
Chicago Concrete Mchy. Co.
Good Roads Machinery Co.

Culverts
Crawfordsville Corrugated Culvert Co.

Derricks and Derrick Fittings
Browning Engineering Co.
Carson Trench Machine Co.
Contractors' Sup. & Equip. Co.
Flory Mfg. Co., S.
Hough Co., Wm. B.
Northern Engineering Works.
Parker Hoist & Machine Co.
Terry & Tench Co.

Ditching Machinery, Steam Shovels, Etc.
Austin Drainage Excavator Co
Atlantic Equipment Co.
Brown Hoisting Mach. Co.
Browning Machinery Co.
Buckeye Traction Ditcher Co.
Carson Trench Machine Co.
Ellicott Machine Co.
Fairbanks Steam Shovel Co.
Flory Manufacturing Co.
Harper Machinery Co.
Hayward Co.
Hough Co., Wm. B.
Ingersoll-Rand Co.
Marion Steam Shovel Co.
Municipal Eng. & Contrg. Co.
Parsons Co., G. W.
Peckham, Fred A.
St. Paul Ditcher & Carrier Co.
Souther & Co., John.
Thew Automatic Shovel Co.
Torbert & Co., A. C.
Vulcan Iron Works.
Vulcan Steam Shovel Co.

Drafting Room Furniture (See also Engineers' Supplies)
Berger Mfg. Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.

Dredging Machinery (See also Ditching Machinery)
Ellicott Machine Co.

Drills—Core, Prospecting
American Well Works.
Cyclone Drill Co.

Drills—Rock and Ore
Cyclone Drill Co.
Ingersoll-Rand Co.
Wood Drill Works.

Dump Wagons (See Carts and Wagons

Dynamometers
Du Vivier, E. H.

Employment Agencies
Assoc. Union of S. S. & D. Engineering Agency.
Graham, J. F.
Hapgoods.
Int. Bro. of S. S. & D'men.

Engineers—Civil, Consulting and Mechanical—(See Engineers' Directory)

Engineers' Supplies, Instruments, Etc.
Am. Blue Print Paper Co.
Buff & Buff Co.
Crofoot, Nielson & Co.
Keuffel & Esser Co.
Kolesch & Co.
Prince, L. M.
Ruehle & Co., E. G.
Seelig & Son, R.
Young & Sons.

Engines—Gas, Gasoline and Oil
American Well Works.

Engines—Hoisting
Brown Hoisting Mach. Co.
Channon Co., H.
Flory Mfg. Co., S.
Harper Machinery Co.
Hough Co., Wm. B.
Northern Engineering Works.
Reliance Mach. & Tool Wks.
Stroudsburg Engine Works.

Engines—Stationary and Pumping
American Well Works.
Channon Co., H.
Cook Well Co.
Erie Pump & Engine Co.
Harper Machinery Co.
Hough Co., Wm. B.
Stroudsburg Engine Works.

Engines—Traction
Harper Machinery Co.

Expanded Metal—(See Fireproof Construction)

Excavating Machinery — (See Ditching Machinery)

Fence and Railing
Anchor Post Iron Works.

Fence Posts—Iron
Anchor Post Iron Works.

Filing Cases (See Drafting Room Furniture)

Filters—Water
New York Continental Jewell Filtration Co.
Norwood Engineering Co.

Fireproof Construction
Berger Mfg. Co.
Calumet Steel Co.
Concrete-Steel Retaining Wall Co.
Hough Co., Wm. B.
Ransome Concrete Mach. Co.
Rodgers Co.
Trussed Concrete Steel Co.

Forms for Concrete Work.
Dietrichs Co., Charles.

Frogs, Crossings and Switches—Railway
Cincinnati Frog & Switch Co.
Indianapolis Switch & Frog Co.
Koppel Co., Arthur.
Weiner Co., Ernst.

Furniture and Office Fittings—(See also Drafting Room Furniture)
Berger Mfg. Co.
Keuffel & Esser Co.

Gauges—Recording
Du Vivier, E. H.

Graders and Scrapers — Earth (See Road Machinery)

Grates—Traveling Link
Green Engineering Co.

Grout Mixer and Injector
Tide Water Iron Works.

Hoists
Hayward Co.
Hough Co., Wm. B.
Ingersoll-Rand Co.
Ransome Concrete Machy. Co.

Hoists—Electric
Grable-Dunn Co.
Northern Engineering Works.

Hoists—High Speed Chain
Chisholm & Moore Mfg. Co.

Hose and Fittings
Ingersoll-Rand Co.

Hydrants
Norwood Engineering Co.

Industrial Railways
Cincinnati Frog & Switch Co.
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Inspection of Iron and Steel
Am. Bureau of Insp'n & Tests.
Conard, W. R.

ENGINEERING-CONTRACTING

A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, Chicago
Telephone Harrison 6756
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt
BOSTON OFFICE: 170 Summer Street
Telephone 5682-4 Main

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . PRESIDENT
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*

***$2.50** a year (52 issues) to Dominion of Canada.*

***$3 00** a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Copy for regular advertising must be received not later than Friday preceding date of issue in which it is to appear. "Proposals," "Wants" and "For Sale" announcements can be inserted as late as Tuesday morning.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

What Is the Practical Value of Hooping as a Method of Reinforcing Concrete Columns 327
The Kind of Cuts to Use in Advertising and the Kind Not to Use. 327
A Legal Decision of Interest to Contractors 328

CONCRETE SECTION:

Results of Tests of Hooped Concrete Columns at the University of Illinois Engineering Experiment Station 329

EARTH AND ROCK SECTION:

Method and Cost of Blasting 1,100 Stumps 336
A Tunnel Excavating Machine for Soft Material 337

ROADS AND STREETS SECTION:

Data on Tarvia Road Treatment in New York State and Tar Macadam Work in Canada. 337
Methods of Dragging Earth Roads. . .340

WATER WORKS AND SEWER SECTION:

Method and Cost of Building a Pipe Sewer Through Quicksand by Excavating the Ground with a Pump. .341

RAILWAY SECTION:

Itemized Cost of the Stampede Tunnel (9,850 Lin. Ft.), and Its Masonry Lining. 342

STRUCTURAL STEEL SECTION:

Method of Erecting a Steel Bridge by Launching 344

GENERAL ARTICLES:

Card Index Order System. 348

What is the Practical Value of Hooping as a Method of Reinforcing Concrete Columns?

The column is the troublesome unit in concrete building work. This is particularly true where the building rises to any height. In order not to involve dangerous unit stresses the size of the column becomes so great for even moderate heights of buildings that the sacrifice of space is objectionable and in many instances inadmissible. It is this fact very largely, we believe, that has accounted for the popular favor received by so-called hooped column construction. Tests showed that in ultimate strength a concrete column reinforced by circumferential hooping was several times superior to a plain column of the same size. This superior strength seemed to make possible the material reductions in column size which the conditions of building work necessitated, for it seemed logical to assume since the factor of safety was the same, the possibility of loading a hooped column having an ultimate strength of 5,000 lbs. per sq. in. to 1,250 lbs. per sq. in. if a plain column having an ultimate strength of 2,000 lbs. per sq. in. could safely be loaded to 500 lbs. per sq. in. Without following this thought any further we will note that a new light has been thrown on the practical value of hooping as a method of reinforcing by the series of hooped column tests being conducted by Prof. Arthur N. Talbot at the University of Illinois testing laboratories. To say the least of them these tests justly raise the question with which we have entitled these remarks.

The results of the first series of Prof. Talbot's hooped column tests are given slightly condensed in another column of this issue. It is not our purpose to enter into a critical technical anaylsis of these tests here, this task may better be left to the expert in such matters. The practical constructor will, however, appreciate the force of certain features of the records obtained without such analysis. The first feature noticed which will be that the reinforcing or restraining action of the hooping of hooped columns does not take effect before a load equivalent to the ultimate strength of plain concrete, or a little below, is reached. The second feature noticed will be that with the critical load at which the hooping begins to act an elastic change occurs in the material, both the longitudinal and lateral deformation become large and a large permanent set or shortening of the column takes place.

Stopping the consideration of the test records here for the present, it may be noted that two methods for determining the design of columns are used. In the first a safe working stress is set for the concrete and the stress in the steel determined by the ratios of the elasticities of steel and concrete. In the second method, the ultimate strength of the column is computed and a factor of safety used by which to divide the breaking load to get the safe load. An examination of building ordinances shows that most of them specify the first method—a safe working stress is set based on the crushing stress of plain concrete cubes. Obviously in such cases hooping cannot be of much service except in case of accident since according to Prof. Talbot's tests it does not come into action until long after the specified stress has been passed.

Considering now the second method of designing, the first question which arises is: Should not the point at which the stated elastic change occurs be regarded as virtually the point of ultimate strength governing the determination of the allowable unit loads? This is a question which to say the least, cannot be answered with certainty offhand. But assuming that the actual ultimate strength be taken as this governing strength, we encounter the factors of deformation and permanent set. In many cases such deformations as Prof. Talbot's tests record are not only objectionable but fatal to the continued usefulness of the column.

Taking the tests as a whole it looks to the practical constructor very much as if hooping was of very little use until the concrete had failed. Doubtless this may be going too far; it is farther than Prof. Talbot goes in his very conservative conclusions. We may note, however, that it has been our purpose to exaggerate matters somewhat with a view of emphasizing the point we wish to make. We do not feel that there is no virtue in hooping as a method of reinforcing columns, but merely that in order to convince the practical constructor of his virtue the hooped column advocates have some work yet to do. One thing is certain of hooped columns, they are a safeguard against sudden collapse. On the other hand hooping, unless supplemented by longitudinal reinforcement gives no increased resistance against lateral breaking and with the introduction of supplementary longitudinals we introduce still further complications in the distribution of stresses. In conclusion we repeat our query: What is the practical value of hooping as a method of reinforcing concrete columns?

The Kind of Cuts to Use in Advertising and the Kind Not to Use.

An illustration, or cut, should serve two purposes when used in an advertisement: First, it should arrest attention; and, second, it should act as an adjunct to the reading matter explanatory of the product advertised. Occasionally it may be wise to use a cut merely to arrest attention, but it is usually better to use a cut that serves the second purpose above mentioned as well as the first. Many advertisements in popular magazines contain cuts that do not serve to supplement the reading matter or to explain the nature of the product. A

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

photograph of a handsome woman, for example, may be used as the illustration in an advertisement of a soap. Such a cut, therefore, serves merely as an eye detainer, the hope of the advertiser being that if the eye pause long enough to admire the picture it may scan the text alongside.

Such cuts are rarely used in technical journals, but this very fact would make their use more effective than elsewhere. Indeed, the greatest fault with cuts seen in trade periodicals is to be found in the fact that they are not of a kind that grasp the glance of a reader and hold it. Ordinarily the cuts in an engineering paper do illustrate the text of the ad, but do not accomplish the first function of an advertising illustration, namely, the function of arresting the attention of the casual reader. Why not? In the writer's opinion the answer is found in the fact that more than 90 per cent of the cuts are photographs of the product advertised. If an entirely new machine is to be advertised, then a good photograph certainly will arrest attention; but, if the machine is of a well known type, the eye sees nothing that it has not seen hundreds of times before, and it makes no longer pause than it would make upon seeing a leaf on a tree.

The use of photographs of machines in the advertising columns of engineering journals has been carried to an extreme. Test yourself and you will see the truth in this statement. If you glance through the advertising pages, you will find that the illustrations that cause you to stop are usually line drawings and not photographs.

Aside from the monotony of a mere picture album of machines, there is another objection to photographs. An electrotype or half-tone begins to grow indistinct and blotchy after a few thousand impressions have been made, and it requires constant vigilance in supplying new electros if the appearance of the advertisement is to be kept creditable. On the other hand, a zinc plate made from a line drawing lasts many times longer and is always clean cut and distinct.

A photograph illustrating a machine at work is, in the writer's opinion, preferable to a photograph of the bare machine, as a general rule. One reason for this is that innumerable photographs can be secured showing work in progress under different conditions. Hence the reader finds something new each time he sees the advertisement. If some valuable data or facts accompany each new photograph, the reader will form a habit of reading the text to gain information.

The effect of an advertisement may be said to be proportional to the time that a reader gives to it. If the reader spends the tenth part of a second glancing at it, and in that time absorbs the firm's name, the advertisement has done some good. But if the reader spends 10 seconds studying the picture and reading the text, the effect of the advertisement is fully 100 times as great upon his memory, and, in addition, there is secured an effect upon his judgment if the advertisement is properly prepared.

Another reason for the more common use of line drawings instead of photographs is this: A photograph becomes more and more indistinct the smaller it is; whereas a very small line drawing may be made to stand out with great distinctness. Hence the advertiser who can afford only small space should almost invariably use a small line drawing of some kind. As it now is, the small space advertisements in engineering journals usually contain nothing but text, with occasionally a trade mark. This is a most serious error, and if you want to see how serious it is, try a comparison by turning to any general magazine. There you will find small space advertisements prepared with effective little cuts and accompanied by much good reading matter in small type.

Who has not seen the "Squab Book" ad, occupying only one inch of space, nearly half of which is covered by the picture of a pigeon? In addition to the cut, this same ad contains 50 words.

If advertisers in engineering periodicals will study the advertisements in general magazines, particularly with reference to illustrations and typography, there will soon be a marked improvement in engineering advertisements, and a corresponding improvement in the results secured from advertising.

The sixth editorial in this series will appear in our next issue, in which we shall give suggestions on writing "drumming advertisements."

A Legal Decision of Interest to Contractors.

A suit involving the question of right to cancel a contract for alleged lack of speed in its execution was recently tried before Justice Charles W. Dayton, of the New York Supreme Court, and a decision rendered in favor of the contractor, Frank B. Gilbreth.

The contractor had undertaken to erect an 8-story reinforced concrete building for the McGraw Realty Co. of New York, under a cost-plus-a-fixed-sum contract. The height of the building was subsequently increased to 11 stories. After the foundation excavation had been completed and walls built up to the curb level, forms made, reinforcement bent and structural steel fabricated for the rest of the building, concrete machinery installed and tower erected for handling the materials, the McGraw Realty Co. cancelled the contract Nov. 2, 1906, retained the contractor's complete organization and plant, and finished the building in accordance with the contractor's shop and erection drawings. The reason given by the McGraw Realty Co. for this action was their fear that the building would not be ready for occupancy on May 1, 1907. The contractor maintained that they were actuated by an entirely different reason, but, without going into this phase of the matter, it is signficant that the bulding was made ready for occupancy before May 1. In addition to this damaging fact, the defendant was also shown to have failed to provide the contractor with a city permit to erect the building before canceling the contract. The contractor contended that this failure to provide him with a building permit had made it impossible for him to build above the curb level, and that all he could do, he had done, namely, build to the curb level, secure materials, make forms, bend the reinforcement, fabricate the steel and install plant for further work. He also contended that the McGraw Realty Co., being inexperienced in concrete building work, did not realize how quickly the rest of the building could be completed after the building permit was secured and the aboxe preparations made.

The question as to the quality of the concrete work was disposed of by Prof. William H. Burr, the defendant's engineer, who stated that all that had been done at the time of the cancellation of the contract was of superior quality.

The jury was asked to return answers to two specific questions: (1) "Did the plaintiff perform his contract so far as he was permitted to do so by the defendant?" The answer was "Yes." (2) "Was the defendant justified in cancelling the contract on his part and forbidding the plaintiff to proceed thereunder?" The answer was "No."

This decision illustrates very clearly the risk that an owner runs in cancelling a contract because of seeming lack of speed. In concrete building work in particular, after the foundation is finished and forms made for the rest of the building, the time of erecting each story is comparatively short. A story a week may be built under fairly good management with an adequate plant.

The trial also shows the duty on the part of the owner himself to leave nothing undone which may retard the work, such as securing building permits and furnishing plans.

The value of photographs in a trial of this sort was well exemplified. Numerous photographs were introduced showing the work in various stages of completion, and showing forms and bent reinforcing metal piled up in the yards, tower and plant in place, and the like.

A description of the method used in erecting this building will be found in our issue of Dec. 16, 1906.

Dynamiters on May 27, according to press reports, wrecked the big pipe line that conveys water from Bonita Mountains, N. Mex., to Carrizozo, N. Mex., where all the engines of the El Paso and Southwestern Railway system are supplied. The pipe line, which diverts the water supply of the Bonita river, cost about $1,000,000.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Results of Tests of Hooped Concrete Columns at the University of Illinois Engineering Experiment Station.*

Thirty hooped columns were tested. The columns were generally cylinders 12 ins. in diameter and 10 ft. long, but a few of other dimensions were used. The ratio of length to diameter ranged from 6 to 13, all being short columns. Tests were usually made at an age of 60 days, but a few tests were made at 6 months. Both bands and wire spirals were used for reinforcement. Columns reinforced with bands will be referred to as band-hooped columns and those reinforced with wire spiral as spiral-hopped columns. The bands were of three weights, No. 8, No. 12, and No. 16 gage, all 1 in. in width. The wire used in the spirals was No. 7 and ¼ in.; both high-carbon and mild-steel wire were used. The concrete was generally a 1—2—4 mixture, but in order to determine the effect of the restraint of the hoops upon richer and leaner concrete, two columns were made with 1—4—8 concrete and two with 1—1½—3 concrete.

Materials.—The materials used in making the columns were similar to the best materials used for this class of work in this section of the country. The stone, sand, and nearly all the cement were bought in the open market. Universal portland cement, used in two columns, was furnished by the makers, but the Chicago AA Portland cement used in the remainder was bought of a local dealer.

Stone.—The stone was crushed limestone from Kankakee, Illinois. It was ordered to pass through a 1-in. screen and over a ¼-in. screen. The stone came in two shipments, and there was an appreciable difference in the quality of the two. The first lot was finer, softer, and of a darker color than the second lot. The harder, coarser stone of the second lot made much the better concrete. Tests showed that this last lot had about 50 per cent voids and weighed 85 lbs. per cu. ft. loose.

Sand.—The sand was of good quality, sharp, well graded, fairly clean, contained 28 per cent voids, as determined by pouring sand into a vessel partly filled with water, and weighed 103 lbs. per cu. ft. loose. It came from near the Wabash River at Attica, Indiana.

Cement.—In all except two columns, Chicago AA Portland cement was used. In two columns Universal cement was used. Table I gives the results of tension tests of these cements made according to standard practice.

Concrete.—Men accustomed to mixing concrete made the test specimens and an effort was made to have the concrete as good as would be used in the best practice. All materials were proportioned by loose volume and weights were taken as a check on the measurement. The mixing was done with shovels by hand. The sand and cement were first mixed dry. The stone, which had previously been thoroughly moistened, was then added and the mass turned until uniform in appearance. Water was added in such proportion as to give a fairly wet mixture. This consistency permitted tamping into the forms to good advantage.

Steel.—The steel used in the hoops had a yield point of about 48,000 lbs. per sq. in. and an ultimate strength of from 60,000 to 65,000 lbs. per sq. in. The hoops were 1 in. wide and of three thicknesses, corresponding to No. 8, 12, and 16 gage. For the spiral reinforcement, both high-carbon and mild-steel wire were used, each being in two sizes, ¼-in. and No. 7. Tests showed that the ¼-in. high-carbon wire had a yield point of approximately 115,000 lbs. per sq. in. The yield point of the No. 7 high-carbon wire was about 60,000 lbs. per sq. in. Their ultimate strengths were about 155,000 and 90,000 lbs. per sq. in., respectively. The ¼-in. mild-steel wire had a yield point of 54,000 lbs. per sq. in. and the No. 7 wire 38,500 lbs. per sq. in. Their ultimate strengths were about 73,900 and 54,000 lbs. per sq. in., respectively. The hoops were electrically welded and as it was desired to know the strength of the weld, pieces containing the weld were tested. Several broke at the weld at a point much below the ultimate strength, but with one exception at a load higher than the yield point of the metal.

Test Specimens.—An effort was made to have the conditions of fabrication of the different test specimens as nearly uniform as possible. Usually the test columns were made in sets of three. Individual columns of a given set were made at different dates throughout the season, the purpose being to make columns of different sets at the same time and thus distribute accidental variations of fabrication over a number of sets.

Band-Hooped Reinforced Columns.—Twelve band-hooped columns were 12 ins. in diameter and six were 9 ins. in diameter. The length was 10 ft. The reinforcing consisted of circular bands of No. 8, 12, and 16 band steel 1 in. wide, generally placed on 2-in. centers. The spacing for one column was 3-in. centers and for two columns 4-in. centers. The bands were held in place by three longitudinal strips of thin metal suitably punched, as shown in Fig. 1.

Spiral-Hooped Reinforced Columns.—Twelve spiral-hooped columns were tested. They were 12 ins. in diameter and 10 ft. long. The reinforcement consisted of a single steel were coiled in the form of a helix and spaced at a uniform pitch of 1 in. by means of heavy steel wires crimped as shown in Fig. 1. Both mild-steel and high-carbon-steel wire were used, the sizes being No. 7 and ¼ in. for each.

Forms.—The column forms were of galvanized sheet steel bent into a cylindrical shape and held in position by bands 1 in. wide and 3/16 in. thick. The bands could be adjusted to the proper diameter by means of bolts. The forms were built in sections 2½ ft. long and fitted together in stove-pipe fashion. The forms are shown with dimensions in Fig. 1.

Making of Columns.—The concrete for each column and for the corresponding cubes and cylinders was mixed in one batch. The form was set up on a cast-iron base plate, 14 ins. by 14 ins. by 1¼ ins., which was planed on both sides and served as a bearing plate in the column test. In making the plain concrete columns the forms were built up in 2½-ft. sections, each section being filled before the next was added. The concrete was put in in layers of about 6 ins. and tamped or churned until water flushed to the top. In making the reinforced columns, the form was placed around the hoops or spirals for the full length of the column, after which it was set up vertically on the base plate. The concrete was put in from the top of the column and tamped or churned as described above. The reinforcement was usually covered by from 1/16 to ¼ in. of mortar. As this outside coat spalled off early in the test and did not add appreciably to the strength of the column, the diameter of the column was assumed to be the same as the diameter of the band or spiral. Generally the column had a very good surface. In the band-hooped columns care was taken to place the bands so that welds were distributed over the circumference of the column. Three or four inches of the ends of the wire in the spiral-hooped columns were bent inward to form an anchorage. The metal in the reinforcement was gaged in several places and the average taken to compute the per cent reinforcement. The lengths of the columns were quite uniform, varying from 10 ft. 1 in. to 10 ft. 4 ins.

Storage of Test Specimens.—The columns were built near the walls of the testing room and remained where made until time of the test. The forms were taken off ten days after making and after that the columns were sprinkled with water twice daily until they were tested. The temperature of the room varied from 55° to 70° F.

---

*Extract from Bulletin No. 20, by Prof. A. N. Talbot, University of Illinois Engineering Experiment Station, Urbana, Ill.

Phenomena of Tests of Hooped Columns.—The general phenomena accompanying the tests of hooped columns are as follows: The earlier part of the test is much the same as for plain concrete columns. At a load equal to that which would cause failure in a plain concrete column, or a little above, the concrete over the spacing bars begins to scale, and this is soon followed with a scaling and shelling off of the surface of the column over the hoops everywhere. With added increments of load beyond the limit of strength of plain concrete the amount of shortening increases rapidly and the column expands or bulges laterally correspondingly rapidly. The maximum load in some cases may not be reached until the hooping has been stressed to its elastic limit, and in other cases this load may be reached without developing the elastic limit of the hooping, especially when large lateral deflection of the column and general distortion from the original shape occur. The lateral deflection of the column from a straight line is apparent before the maximum load carried is reached—in many cases considerably before. After the maximum load is passed, the lateral deflection rapidly increases. During the last stage of the test the column usually forms a curve having the characteristics of the figure shown in text books for a column with fixed ends. Some columns finally bent out of line as much as 4 or 5 ins., although the load then carried was only a small proportion of the maximum and this condition could not obtain under a dead load.

There was a variation in the time of the first noticeable lateral bending in the tests. Generally speaking, in the case of companion columns, this bowing was perceptible first in the one which gave the lowest maximum strength. This load at which bowing became apparent ranged from 60 per cent to 85 per cent of the maximum load of the column in the case of the band-hooped columns and from 70 per cent to 95 per cent in the case of the spiral-hooped columns, though in the latter the average was nearly 90 per cent. However, it was evident that slight bending began earlier than this. The amount of this bowing at the time of the maximum load was not large, but its presence, or the presence of the conditions which caused the bending, must have had much to do with the final failure of the column. In most of the tests, after passing the maximum load, the bending increased rapidly under loads smaller than the maximum and the column can not be considered to have failed by direct crushing.

The amount of shortening in the hooped column at the maximum load, as compared with plain concrete columns at their maximum load was very great. The total amount of shortening in a hooped column 10 ft. long ranged from ¾ in. to 1¾ ins., and the corresponding longitudinal unit deformation was from 0.006 to 0.015. This is six to twelve times the shortening in a plain concrete column at its maximum load. The amount of set produced in the column is very great. In Column No. 173, for a load well below the ultimate strength of the column, this set was 0.0025 per unit of length, or over two-thirds of the total unit shortening of the column at the first application of the load.

The purpose of reinforcing concrete columns with hooping is to restrain the concrete laterally and to add to the strength of the column by preventing the disintegration of the concrete when that limit of lateral expansion has been reached for which in plain concrete rupture is produced by the internal tensile or shearing stresses developed. A little study will show that the effect of the hooping for loads below the ultimate strength of plain concrete must be relatively small. Consider that the load on the column is 800 lbs. per sq. in., about one-half of the ultimate strength of the plain columns for the 1—2—4 columns 60 days old of the tests under consideration. The amount of shortening for a concrete column at half its ultimate load may be considered to be 0.0003 unit per unit of length (inches per inch of length). If we consider that Poisson's ratio for this concrete is ⅛, the lateral expansion for the column will be 0.0000375. Even if we consider that the steel hooping would receive this unit deformation the stress in the hooping would be only 1,100 lbs. per sq. in., and reasoning from this it seems evident that the effect of the hooping for lateral deformations of this amount is very slight. A comparison of the stress-deformation diagrams for plain columns and for hooped columns shown in succeeding pages bears this out. It seems probable that voids left in the concrete may interfere with early pressure on the hooping. For columns reinforced with steel rods placed longitudinally in the column, with a load on the column giving a shortening of 0.0003, the stress in the steel would be 9,000 lbs. per sq. in., a much larger amount proportionally. For hooped columns, if the value of Poisson's ratio remains at ⅛ for higher loads, the stress in the hooping would increase somewhat proportionally. When the longitudinal shortening became 0.001, the steel in the hoops would be stressed 3,750 lbs. per sq. in. If the value of Poisson's ratio increases as the load at which plain concrete would fail is approached, considering it to be 0.25 at this point and considering also that the longitudinal shortening of the column at this load is 0.001, the stress in the hooping would become 7,500 lbs. per sq. in. Beyond the load which would produce failure in unrestrained concrete the conditions in the columns change materially, as is shown in succeeding pages, and the hooping receives additional stress rapidly and its function in maintaining the integrity of the concrete is important. It is to be expected that if other conditions were maintained the limit of strength of the column would be reached when the hoops become stressed to their yield point.

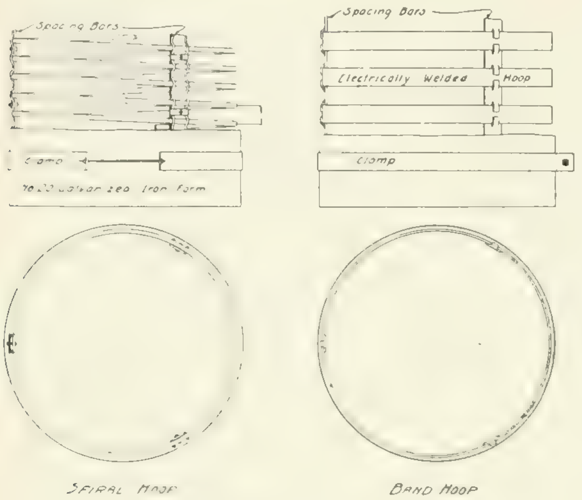


Fig. 1—Sketch Showing Forms and Reinforcement.

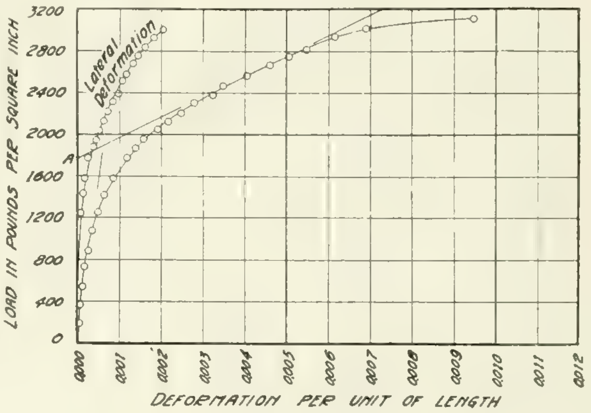


Fig. 2—Stress Deformation Diagram for Band Hooped Columns.

It is also to be expected that if the hooping becomes pressed into the concrete, or if by reason of lack of homogeneity or other cause the column bends or deflects laterally and the pressure is unevenly distributed, the maximum load may be reached before the hoops can become stressed to their yield point. The tests indicate that such conditions exist.

Stress-Deformation Diagram for Hooped Columns.—Figure 2 shows Column No. 138, which was reinforced with steel bands and which may be considered to be typical of the banded columns. Figure 3 shows Column No. 182, which was reinforced with spiral hooping and which may be considered to be typical of the spiral-hooped columns. An examination of all the diagrams shows that the stress-deformation diagram given by hooped columns is much the same as that given by plain concrete columns up to that load which would cause failure in a plain concrete column and up to an amount of shortening in the column of, say 0.001 or 0.0015, unit deformation. That is to say the comparison shows a very close relation between loads and shortenings for the two classes of columns up to the point of failure for plain concrete columns. For loads greater than the ultimate strength of plain concrete, the shortening of the hooped columns increases very rapidly, the ratio of the increment of load to the increment of longitudinal deformation (unit shortening) being only something like 100,000 to 200,000, varying according to the amount of reinforcement. The stiffness of a hooped column for the added load after the hooping has come into action is therefore very small as compared with that of a plain concrete column within its limit of strength. The stress-deformation line at this stage of the test is fairly straight and it gradually swings to a horizontal position as the maximum load of the column is reached. Beyond this horizontal portion, if the test is continued, the load falls off and the shortening is continued as the column gradually bends out of line. If the straight line which fits the part of the stress-deformation curve where the hooping is effective be produced back to the axis of ordinates (as shown in Figs. 2 and 3) the intersection agrees closely with the load which produces a longitudinal shortening of 0.001 or 0.00015. As stated later, there is a good indication that this agrees closely with the strength that the column would have without hooping. The agreement of these values is noteworthy. The general slope of the stress-deformation curve above this point varies with the amount of the reinforcement. It will be seen that there is some difference in the amount of deformation for columns hooped with bands and with spirals. This is discussed in a succeeding paragraph. It must be borne in mind that the values shown by these lines are not very accurate, but they serve to give an idea of the relation existing. Attention is called to the fact that these deformations are all based upon the original length of the column, since that is the condition which would exist in construction, and that the effect of set is not here considered.

Modulus of Elasticity and Compressive Deformations.—If the hooping is effective in any marked degree at the beginning of the test it may be expected that the initial modulus of elasticity will be greater for hooped columns than plain concrete for columns and that the stress-deformation diagram will show that the column is stiffer for loads up to the ordinary compressive strength of concrete. It is worth while to make an examination of the portion of the stress-deformation curve for the first stage of the test. To do this the point where the first marked change occurs in the direction of the line from that for plain concrete, or which corresponds with the ultimate longitudinal deformation found in plain concrete columns (ranging from 0.001 to 0.0015) indicated in the tables by e', is determined. A study of the diagrams makes it seem probable that the load causing this shortening corresponds closely with the ultimate strength of the concrete of the column. Tables II and III give the results found. The variation in these values is not greater than that found in plain concrete columns, but the average strength is somewhat less than the average for the plain concrete columns of the same mix and age. The tests of cubes and cylinders from the same mix, so far as these were made, confirm the belief that the values thus found are representative of the strength of the concrete. It is interesting to note that the load thus obtained agrees fairly well with that found by taking the straight portion of the stress-deformation curve as it averages beyond the elbow and extending it backward to an intersection with the axis of ordinates (A in Fig. 2 and 3). After determining the critical point above described, the calculation of the initial modulus of elasticity may be made by the method used for plain concrete columns. These results are also given in Tables II and III.

TABLE I.—TENSILE STRENGH OF CEMENT

Ref. No.	Chicago AA Cement				Universal Cement			
	Age 7 days		Age 28 days		Age 7 days		Age 28 days	
	Neat	1-3	Neat	1-3	Neat	1-3	Neat	1-3
1	786	230	811	265	410	187	680	370
2	683	145	851	235	470	200	670	330
3	760	218	861	225	360	120	560	360
4	786	186	760	270	405	145	570	290
5	866	215	965	265	320	195	600	295
6	815	211	935	287	310	180	620	310
Av.	783	201	864	258	379	171	617	326

Ultimate Strength, Pounds per Square Foot

The initial modulus of elasticity for the first stage obtained in this way averages about 2,610,000 lbs. per sq. in. for the hooped columns made of 1—2—4 concrete. The average initial modulus of elasticity for the corresponding plain concrete columns is 3,040,000 lbs. per sq. in. As a matter of fact the determination of this initial modulus of elasticity for hooped columns is subject to variation of judgment, but it appears then that the hooped columns are less stiff through the first stage than are the plain concrete columns. Using the parabolic relation to determine points for lower loads than the assumed ultimate strength of the concrete (the method found satisfactory for the plain concrete), the calculated points so obtained show a very close agreement with the observed stress-deformation curve. No reason is known for the apparent decrease in stiffness, though the presence of the hooping may affect the fabrication of the columns or their shrinkage in setting and the density of the concrete. At any rate, it seems evident that there must be very little restraint by the hoops through this stage. An analytical treatment of the stresses which may be developed in hoops, especially with the low value of Poisson's ratio then acting, leads to similar conclusions.

When loads are applied which give shortenings larger than 0.001 to 0.0015, the second stage begins and a considerable stress is brought into action in the hooping. As the load is added the restraint of the hooping becomes marked and there is a very rapid increase in the amount of shortening produced by the added load. The stress-deformation diagram, through this stage of the test, approximates a straight line for the banded columns. For those with spiral reinforcement only a small portion is straight, but the main part of the curve has one general direction. The ratio of the increment of load to the increment of deformation, however, is comparatively small. It is well to compare this ratio with the modulus of elasticity of concrete. The values for this ratio, determined from the stress-deformation diagrams, are given in Tables II and III, in the columns headed "Ratio of Increments," e'' being the unit deformation corresponding to the maximum load. The average value for this ratio for columns with band reinforcement is 184,000; for those with spiral reinforcement, 165,000. This ratio is very much less than the modulus of elasticity of concrete. The values of Columns Nos. 152 and 153 show that the ratio becomes much smaller for leaner concrete; but those for Columns Nos. 157 and 158 indicate that it is higher for the richer mixture. Attention is called to the fact that the deformations used refer to the original length and not to the length after the set is deducted.

It will be seen that the amount of shortening in the column before the maximum load is reached depends upon the amount of reinforcement, and that it is more for columns with spiral reinforcement than for columns reinforced with bands. The average value for the banded columns given in terms of the excess of the unit shortening of the hooped column over the shortening for a plain concrete column per 1 per cent of reinforcement ranges from 0.0031 to

0.0059 for the columns with spiral reinforcement and 0.0013 to 0.0035 columns reinforced with bands. Attention should be called to the fact that the columns reinforced with spiral will sustain higher loads, as well as shorten more, than the columns reinforced with bands. It is not known whether the concrete bulged out more between the spirals than between the hoops, but this condition seems probable.

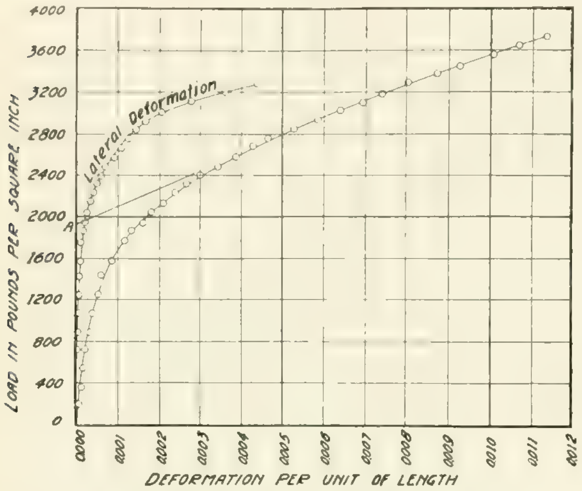


Fig. 3—Stress Deformation Diagram for Spiral Hooped Columns.

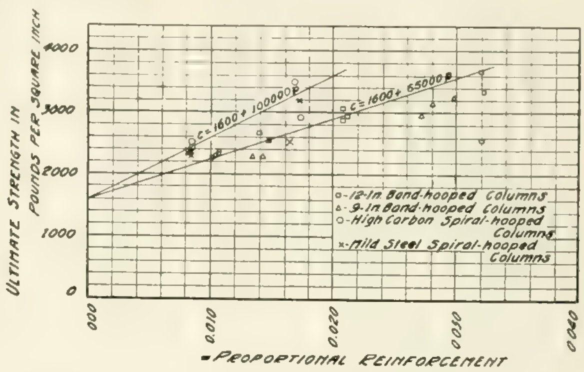


Fig. 4—Diagram Showing Ultimate Strength of Hooped Columns.

Strength of Hooped Columns. In Table IV are given the loads carried by the columns reinforced with bands, and in Table V those with spiral reinforcement. Fig. 4 shows the results graphically. It is evident that hooping adds strength and that the excess of strength over that of plain concrete columns is proportional to the amount of reinforcement. The full effect of the hooping is not clearly shown in Fig. 4 since the concrete in each column has its individual strength. A better comparison is made by first estimating the strength of the concrete for each column as found in "23. Modulus of Elasticity and Compressive Deformations." If the increase in strength over that of a plain concrete column be divided by the per cent of reinforcement, the additional strength per 1 per cent of reinforcement is obtained. This is shown in Table II and Table III in the columns headed "Additional strength per 1 per cent of reinforcement." It is also shown graphically in Fig. 5. The strength assumed for the concrete of the individual columns involves errors of judgment, even if the method of determining it is considered to be a proper one, but a careful study of the diagrams shows that the variation due to judgment may not, for average of the results, amount to more than 50 lbs. per sq. in. above the values assumed, and this variation will not seriously affect the values found for the added strength of the column due to hooping. The strength of the 1—2—4 concrete given for the hooped columns is less than the average for the 1—2—4 concrete columns. Part of this may possibly be due to difference in materials and part to the effect of the presence of the hooping upon the density of the concrete.

For the columns reinforced with bands there is a fair agreement in the value of this additional strength per 1 per cent of reinforcement for all the 12-in. columns regardless of the amount of reinforcement. The average is 669 lbs. per sq. in., if we except Column No. 148, which appears by the stress-deformation diagram and other data to be erratic, probably the result of poor concrete or of defective hooping. The 9-in. band-hooped columns are also fairly uniform, the average additional strength being 537 lbs. per sq. in. per 1 per cent of reinforcement. It is noticeable that the additional strength per 1 per cent of reinforcement in these 9-in. columns is much the same for the 1—4—8, 1—2—4 and 1—1½—3 concrete, and that the difference in the strength of these columns seems to show up mainly through a difference in the strength of the concrete itself. It should be recalled, however, that the hooped column with 1—4—8 concrete is much less stiff through the second stage than is that with 1—1½—3 concrete. The reader should also keep in mind the low degree of stiffness in hooped columns, as discussed elsewhere.

TABLE II—PROPERTIES OF BAND-HOOPED COLUMNS.

Col. No.	Per cent Rein	Strength of Column in lb. per sq. in.		Additional Strength per 1% of Reinforcement lb. per sq. in.	ε'	Initial Modulus of Elasticity lb. per sq. in.	ε''	Ratio of Increments.
		Concrete from Diagram	Maximum					
			12-in. Columns.					
131	1 085	1600	2384	725	0012	2 670 000	.004	196 000
132	1 085	1400	2150	690	.0012	2 340 000	005	150 000
133	1 050	1450	2182	695	0011	2 640 000	.0045	163 000
136	2 081	1600	2860	605	0011	2 910 000	006	210 000
137	2.071	1200	2660	705	0012	2 000 000	0085	172 000
138	2.12	1750	3110	640	0012	2 920 000	.007	194 000
146	3.22	1250	3000	545	.0011	2 280 000	0103	170 000
147	3 20	1650	3715	645	0013	2 670 000	009	230 000
148	3 20	1900	2890	310	0012	3 160 000	0055	180 000
143	1.39	1650	2735	780	0011	3 000 000	0055	197 000
141	1.02	1600	2275	660	0012	2 670 000	0045	150 000
142	1.02	1500	2178	665	0010	3 000 000	0045	150 000
			9-in. Columns					
152*	1.35	650	1345	515	0012	1 080 000	008	87 000
153*	1.41	600	1260	470	.0010	1 200 000	008	83 000
151	1.47	1200	2140	640	.0010	2 400 000	004	235 000
156	2 73	1600	2970	500	0012	2 670 000	0063	218 000
157*	2 94	1950	3561	550	0011	3 550 000	006	269 000
158*	2.80	2150	3685	550	0011	3 910 000	0058	265 000

*All the columns were of 1-2-4 concrete, except 152 and 153, which were 1-4-8, and 157 and 158, which were 1-1½-3

For spiral hooping there is a greater additional strength per 1 per cent of reinforcement, and also more variation in the results. Omitting No. 186, which seems to be poor material, the average additional strength per 1 per cent of reinforcement for these columns is 955 lbs. per sq. in., which is about 50 per cent greater than the additional strength found in the columns reinforced with bands. There seems to be little difference between the strength given by the high-carbon wire and the mild-steel wire, especially when it is remembered that the No. 7 high-carbon wire has a yield point of 60,000 lbs. per sq. in. and the ¼-in high-carbon steel wire of 110,000 lbs. per sq. in. The results with the mild-steel wire are somewhat lower, but not so much as might be expected when difference in elastic limit is taken into consideration.

TABLE III Properties of Spiral Hooped Columns
(All the columns were made of 1-2-4 concrete.)

Col. No.	Per cent. Rein.	Strength of Column, lb per sq. in. Concrete from Diagram	Strength of Column, lb per sq. in. Maximum	Additional Strength per 1% Reinforcement lb per sq. in.	ϵ'	Initial Modulus of Elasticity lb. per sq. in.	ϵ''	Ratio of Increments
				High-carbon Steel				
171	0 85	1600	2503	1060	.0012	2 670 000	005	180 000
172	0 85	1700	2506	950	0012	2 840 000	005	161 000
173	0.82	1400	2010		0010	2 800 000		
181	1.73	1400	2718	760	0014	2 000 000	010	127 000
182	1.67	1900	3800	1140	0014	2 720 000	011	173 000
183	1 68	1900	3793	1130	0015	2 540 000	011	172 090
				Mild Steel				
176	0 84	1350	2080	870	0012	2 250 000	0045	162 000
177	0 85	1500	2203	830	0012	2 500 000	0045	156 000
178	0 84	1450	2220	920	0012	2 420 000	005	154 000
186	1 64	1150	2068	560	0012	1 920 000	008	115 000
187	1 71	1800	3404	940	0011	3 280 000	0065	247 000
188*								

*Not included in this table on account of being loaded eccentrically.

What the cause is of the greater added strength per 1 per cent of reinforcement with the spirals than with the bands cannot be stated. The observations indicate that the lateral deformation of the concrete between hoops at the maximum load is greater in columns with spirals than in those with bands. Considering this and also that the columns with spirals compress more before final failure, as shown by the stress-deformation diagrams, and that the stress-deformation curve bends out of a straight line into a long curve, it would seem possible that the concrete squeezes out between the hooping, so to speak, in a larger proportional degree with the spiral reinforcement and thus that the spiral hooping was not stressed up to its elastic limit. The measurement of the stretch in the bands indicates that in some of the columns this material reaches its elastic limit. It seems evident that the hoops are stretched more at their edges than at their center. It is likely that in the placing together of the band reinforcement by the workmen in the laboratory the structure formed was more uneven and less perfect than was the spiral reinforcement. The whole question is complicated by the bulging or lateral deflection of the columns, and this appeared at a relatively earlier stage with the bands than with the spirals. A study of the readings of the individual extensometers indicates that there may be quite a difference in the amount of shortening at points around the column before lateral deflection of the column is noticeable. As this part of the problem was unexpected, the observations were not made carefully enough to state definite results.

A general form of formula for hooped columns may be given as follows:

$$c = c' + pc''$$

where c is the maximum strength of the hooped column, c' is the strength of the plain concrete column, c'' is a coefficient for the hooping and p is the ratio of reinforcement found by dividing the total volume of the hoops by the volume of the core within the hoops; in other words, by considering the hooping to be distributed as a thin cylinder continuously along the hooped column.

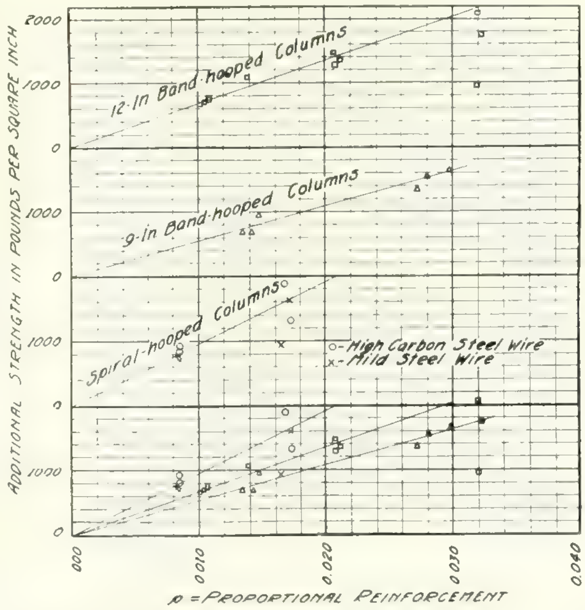


Fig 5—Diagram Showing Additional Strength Due to Hooping.

The values given by the writer in the Proceedings of the American Society for Testing Materials, for 1907, are not far from the average results for the 12-in. columns. Using these, the expression for the columns reinforced with bands may be given as

$$c = 1,600 + 65,000\ p$$

and that for the spiral as

$$c = 1,600 + 100,000\ p$$

The latter equation may be considered to give values too large for the mild-steel wire and smaller than the average for high-carbon-steel wire. Considerable variation from these values may be expected.

Lateral Pressure and Stress in Hooping.—The expansion of the column under load is accompanied by a lateral pressure and this pressure develops stresses in the hooping. It seems from the stress-deformation diagrams that the lateral pressure is proportional to the excess of the load over the strength of the plain concrete. The observations made on the expansion of the bands also indicate that the stress in the hooping is proportional to the increments of load beyond the load which plain concrete would resist. No analytical treatment of the stresses produced by the concrete as it expands will be gone into, but it may be worth while to see what stresses are possibly developed in the hooping and what the relation between the longitudinal compressive stress and the lateral expansive stress may be. It is evident from the tests that many of the band-hooped columns failed by the bands becoming stressed beyond the yield point of the metal. This gives a clue to the amount of stress existing.

The following nomenclature is used: t' the thickness of band, b the breadth of one band, a the distance from center to center of bands or spirals, t'' the diameter of the wire of the spiral, p the ratio of the volume of the hooping to the volume of the core or part of the column within the hooping, and d the diameter of the hooped core. Then the equivalent thickness of an enveloping cylinder of metal is for the band hooped columns

$$t = \frac{b}{a} t'$$

and for the spiral hooping

$$t = \frac{t''^2}{ad^2}.$$

For either case we have

$$t = \frac{pd}{4}$$

If we consider by analogy that the lateral pressure is caused by a lateral pressure in the concrete similar to hydrostatic pressure, using P as this lateral pressure in pounds per square inch, we shall have from the ordinary formula for thin cylinders

$$P = \frac{pf}{2}$$

where f is the stress in the hooping in lbs. per sq. in. If now the stress in the hoops for the maximum load on the column be taken at the yield point of the material, 48,000 lbs. per sq. in., this gives

$$P = 24{,}000$$

or 240 lbs. per sq. in. equivalent lateral pressure for each 1 per cent of hooping. The formula already used considers that 650 lbs. per sq. in. added compressive strength is given for 1 per cent of band hooping. From this it would seem that the ratio of the equivalent lateral pressure to the added strength given by the reinforcement in the case of the band-hooped columns is 0.36. The probability that many of the columns failed by lateral bending and without stressing the bands to the elastic limit should be kept in mind in this connection. While this may not be an accurate value it may give some indication of the ratio between the lateral stress and the longitudinal stress in such columns.

Conditions of Hooped Concrete After Testing.—An experiment of some interest was made by first loading a hooped column and then stripping the wire from it and testing the naked column. Column No. 173 (No. 7 wire, 0.82 per cent reinforcement) was loaded to 2,000 lbs. per sq. in. with a resulting unit shortening of 0.0036. The load was then released and a set of 0.0025 was found. A load of 1,945 lbs. per sq. in. was then applied, when the unit shortening became 0.0041. Upon the releasing of this load the set was found to be 0.0027. The spiral was then stripped from the column without taking it from the machine and a load was applied to the naked column. The column failed at 1,080 lbs. per sq. in. The indications of the stress-deformation diagram are that the plain concrete had a strength originally of about 1,400 lbs. per sq. in. It seemed likely that the stripped column sustained as much as 75 per cent of its original strength as plain concrete. A comparison with the other columns and the form of the stress-deformation diagram indicates that the hooped column might have held 2,400 lbs. per sq. in. before failure.

Eccentric Loading.—Column No. 188 was tested with the pressure applied both top and bottom along a line of 1¼ ins. away from the center of the column. This column was reinforced with ¼-in. wire giving 1.62 per cent of reinforcement. The phenomena accompanying the test were similar to those for central loading except that the lateral deflection was apparent at an earlier load and increased rapidly. The lateral deflection amounted to 0.72 in. when the maximum load was reached. Fig. 6 shows the deformations on two sides of the column and also the amount of lateral deflection. When the eccentricity of the load is considered and also the amount of eccentricity due to the lateral bending, the final loading carried agrees very closely with what would be expected with a homogeneous column under the same conditions. It is evidently not necessary to have the internal pressure uniformly distributed over the cross section of the column in order to utilize the strength of the hooping, as would be the case if the internal presure were considered to act in a manner similar to hydrostatic pressure. The column tested showed considerable toughness, a property which would not be present in plain concrete eccentrically loaded.

Summary.—The writer feels that there is yet much to be learned about concrete and reinforced concrete columns. After making the tests described he has had to give up several preconceived notions of the action of hooped concrete, notions based upon meager statements of tests and analyses made from assumed conditions. The tests here given are not altogether conclusive, but they may help to clear up uncertainties and give an idea of the action of concrete when restrained by hooping. The tests on plain concrete columns also bring out instructive results. The following observations on the tests may be made:

1. The average ultimate strength of the plain concrete columns at ages not far from 60 days is as follows: 1—1½—3 concrete, 2,300 lbs. per sq. in.; 1—2—4 concrete, 1,740 lbs. per sq. in.; 1—3—6 concrete, 1,030 lbs. per sq. in.; 1—4—8 concrete, 575 lbs. per sq. in. The effect of the amount of cement used in the concrete is very marked, and cement is shown to be an economical reinforcing material for compression members. The average variation of individual results from the average strength in the case of 1—2—4 concrete about 60 days old is 12 per cent, ranging from 34 per cent below to 25 per cent above the average. The tests made at an age of 6 months indicate an increase of something like 15 per cent over the strength at 60 days.

2. The average initial modulus of elasticity of 1—2—4 concrete columns at an age of about 60 days was 3,040,000 lbs., per sq. in.

3. Poisson's ratio for concrete in compression is a variable quantity, increasing considerably just before the ultimate failure of the concrete. The value varies with the age and nature of the concrete. A value of 0.1 to 0.16 for 1—2—4 concrete 60 days old may be tentatively given for the lower loads, with values as high as 0.25 or 0.3 near the crushing load. This concrete set in air.

4. The repetition of a load given an increased amount of shortening and an increased set, the amount of this increase varying with the amount of the load. For the lower loads the increase becomes small after a small number of repetitions. For the higher loads the effect of continued

TABLE IV.—SUMMARY OF TESTS OF BAND-HOOPED COLUMNS.

Col. No.	Kind of Concrete	Reinforcement			Maximum Load		Age at Test Days
		Size and Spacing of Bands	Section of Band, sq. in.	Per Cent	Total Pounds	Pounds per. sq. in.	
		12-in. Columns.					
131	1-2-4	No. 16, 2 in. cc.	.065	1.08	270,000	2384	60
132	1-2-4	No. 16, 2 in. cc.	.065	1.08	243,000	2150	57
133	1-2-4	No. 16, 2 in. cc.	.063	1.05	247,000	2182	59
136	1-2-4	No. 12, 2 in. cc.	.125	2.08	323,000	2800	63
137	1-2-4	No. 12, 2 in. cc.	.124	2.07	300,500	2660	69
138	1-2-4	No. 12, 2 in. cc.	.127	2.12	351,000	3110	60
146	1-2-4	No. 8, 2 in. cc.	.193	3.22	339,000	3000	60
147	1-2-4	No. 8, 2 in. cc.	.192	3.20	420,000	3715	66
148	1-2-4	No. 8, 2 in. cc.	.192	3.20	327,000	2890	63
143	1-2-4	No. 12, 3 in. cc.	.125	1.39	309,000	2735	60
141	1-2-4	No. 12, 4 in. cc.	.122	1.02	256,000	2275	59
142	1-2-4	No. 12, 4 in. cc.	.122	1.02	246,000	2178	66
		9-in. Columns					
152	1-4-8	No. 16, 2 in. cc.	.061	1.35	86,000	1345	70
153	1-4-8	No. 16, 2 in. cc.	.063	1.41	80,000	1200	56
151	1-2-4	No. 16, 2 in. cc.	.066	1.47	137,000	2140	65
156	1-2-4	No. 12, 2 in. cc.	.123	2.73	190,000	2970	67
157	1-1½-3	No. 12, 2 in. cc.	.132	2.94	228,000	3561	67
158	1-1½-3	No. 12, 2 in. cc.	.126	2.80	234,000	3685	81

repetition is much more marked. The phenomena attending repetitive loading of columns are important and merit much fuller investigation.

5. In hooped columns the hooping does not come into action to any great extent before a load equivalent to the ultimate strength of plain concrete, or a little below, is reached. The longitudinal deformation and the lateral deformation are not modified by the hooping to any great extent before this load is reached.

6. Beyond this load the column shortens rapidly and the hooping receives additional stress correspondingly and its function in restraining the concrete laterally becomes important. If the column maintains a straight position, the limit of strength may be expected to come when the stress in the hooping exceeds the yield point of the metal. If the column deflects laterally through eccentric loading or lack of uniformity in the concrete or in the distribution of the hooping, a lower strength will be found

TABLE V.—SUMMARY OF TESTS OF SPIRAL HOOPED COLUMNS

(In all cases pitch of spiral was 1 in.)

Col. No.	Kind of Concrete	Reinforcement			Maximum Load		Age at Test days
		Size of Wire	Section of Wire, sq. in.	Per cent	Total pounds	Pounds, per sq. in.	
			High-carbon steel				
171	1-2-4	No. 7	.025	0.85	283 000	2503	56
172	1-2-4	No. 7	.025	0.85	283 000	2506	63
173*	1-2-4	No. 7	.024	0.82	277 000	2000*	57
181	1-2-4	¼-in.	.052	1.73	307 000	2718	57
182	1-2-4	¼ in	.050	1.67	429 000	3800	60
183	1-2-4	¼-in.	.050	1.68	428 000	3793	63
			Mild steel				
176	1-2-4	No. 7	.025	0.84	235 000	2080	60
177	1-2-4	No. 7	.025	0.85	249 000	2203	64
178	1-2-4	No. 7	.025	0.84	251 000	2220	61
186	1-2-4	¼ in	.049	1.64	234 000	2068	58
187	1-2-4	¼-in	.051	1.71	385 000	3404	62
188	1-2-4	¼-in.	.048	1.61	147 000		59

*This column was not tested to destruction as a hooped column, but after a load of 2,000 lbs. per sq. in. had been applied, the spiral was stripped from the concrete and the resulting plain concrete core tested as noted in the text.

7. The additional strength of the hooped column over that for an unreinforced concrete column of the same quality, as determined from the stress-deformation diagram, averages for each one per cent of hooping 955 lbs. per sq. in. for the spiral hooped columns and 669 lbs. per sq. in. for the band-hooped columns having a diameter of 12 ins. The additional strength per one per cent of reinforcement is much the same for 1—4—8 concrete, 1—2—4 concrete, and 1—1½—3 concrete, but it must not be overlooked that the 1—4—8 concrete, is much less stiff than are the columns with richer mixtures, especially after the hooping is brought into action. The difference between the strength of columns with high-carbon wire and with mild-steel wire is not marked enough to warrant drawing conclusions.

8. For loads which bring the hooping into full action, the increase in the longitudinal deformation and in the lateral deformation are approximately proportional to the added load. The ratio of lateral to longitudinal deformation is more nearly constant than for plain concrete. Through this stage the ratio of increment of load to increment of longitudinal shortening is low, the averages for columns with band-hoops being 184,000 and with spiral-hoops 165,000. This ratio is very much less than the modulus of elasticity of concrete and the hooped columns through this stage of loading are correspondingly less stiff than concrete columns. The amount of the set produced by the higher loads is very great.

9. The total amount of shortening before failure occurs is very great, averaging something like six to twelve times that for plain concrete and fifty times that for the ordinary working stresses in concrete. At the maximum load it is somewhat less than this, say five times as much as plain concrete and perhaps five times that of mild steel at its elastic limit. Cracking and peeling of the concrete are apparent at loads corresponding to the ultimate strength of concrete:

10. The excessive amount of compression before failure affects the problem of combining hooping and longitudinal reinforcement very unfavorably, if the stresses are to be kept within the elastic limit of the latter.

11. The lateral deflection of hooped columns is large and may seriously affect the ultimate strength which is available for the column. For continued application of stress beyond the maximum load, the column deflects enormously. Scaling of the surface of the concrete and lateral deflections are warning signs given well before danger of failure exists.

12. The concrete itself retains a considerable element of its strength even after it has been shortened in a hooped state four or five times as much as would produce failure in unhooped concrete columns.

13. Columns of rich and lean concrete exhibit phenomena of similar characteristics, the hoop stress becoming effective at the ultimate strength of unhooped concrete.

14. The one experiment indicates that hooped columns will resist eccentric stresses in somewhat the same way as will other material.

15. Light hooping offers security against sudden failure and unevenness of concrete and will enable higher working stresses to be used. In combination with rich concretes and longitudinal reinforcement, using low stresses in hoops (i. e., basing the strength upon an assumed ultimate strength but little beyond the average strength of plain concrete), a satisfactory column may be made. It is suggested that a column of this character may be designed in such a way that the longitudinal reinforcement may carry the load during construction and still not be overstressed later with the final loading, provided the basal point for use with the factor of safety in determining the working strength of the column is somewhat below the ultimate strength for plain concrete.

16. Heavy hooping gives added strength, but in utilizing the full strength of such columns the column shortens unduly, deflects laterally, and will strain longitudinal reinforcement many times beyond the deformation which exists at the elastic limit of the metal. It may be applicable where a large limit of safety is desired or where large variations in shortening are unobjectionable, as where the structure is articulated. So far as ultimate strength is concerned, hooping adds two to three times as much strength to the column as does an equal amount of longitudinal reinforcement, but with the extreme amount of shortening and the liability to lateral deflection it may be doubted whether this increase of strength may be utilized to any great extent in ordinary construction.

The Northern Pacific railway will plant 100,000 Golden Russian willows between Fargo and Valley City to act as a snow fence. The willows are said to be a good substitute for a snow fence and are less susceptible to damage by fire.

A considerable amount of reconstruction work is proposed for this summer by the Inlet Swamp Drainage District of Illinois. According to the reports of the engineers recently submitted to the Commissioners, the improvements will require 1,533,240 cu. yds. of common excavation and 189,550 cu. yds. of rock excavation. It is expected that bids will be called for in the early summer. A. M. Shaw, Dixon, Ill., is Consulting Engineer, and further information can be obtained from him.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Method and Cost of Blasting 1,100 Stumps.

In grubbing stumps from land, one of the most economic methods is by blasting, provided care and judgment are shown in the use of explosives. The tendency seems to be to use a larger amount of explosives than is necessary. Then, too, different kinds of explosives are sometimes used in the same charge, such as dynamite and Judson powder. This should not be done. But one kind of powder should be used in a hole. For small and medium sized stumps dynamite will give the best results, but Judson powder will do efficient work on large stumps, and, at times for very large stumps, black powder is the cheapest to use.

The charge should be placed well up under the stump and as near the center of the stump as possible. A bar is generally the best tool for making the hole. When only one charge is placed under the stump it is more economical to use fuse and a cap. It is possible in stump blasting to use single tape fuse, but, if the ground is very wet, it may misfire. Under such conditions it is better to use double tape fuse. When several charges are placed under one stump, it is always advisable to use electrical exploders, so that the charges will be exploded simultaneously. For a single charge, electrical fuses are too expensive.

In the job, the cost of which we give below, dynamite was used exclusively, and caps and fuse were used for most stumps, but electrical exploders were used on some, as several charges were placed under some of the largest stumps. There were 1,100 stumps blasted from 4 acres of land, the job being in eastern New Jersey. The trees had been cut about 2 years, and were mostly white oak and hickory. They varied in size from 4 ins. to 6 ft., the average size of the 1,100 stumps being about 15 ins. in diameter.

The dynamite used was 40 per cent. The ground was full of large boulders, and more fuse, single tape, was used than would have been required if the ground had not been full of stones. The long fuse was necessary in order to allow the men time to get away from the flying pieces of stone. Two men only were used. One man handled the dynamite and the other prepared the holes. These men did nothing towards cleaning up the stumps after they were blasted.

The cost of the labor was as follows:

Dynamiter, 19 days at $3.50	$ 66.50
Helper, 19 days at $1.50	28.50
Total	$95.00

The cost of the explosives was:

850 lbs. dynamite, at 15 cts.	$127.50
1,300 caps at 75 cts. for 100	9.75
1,300 ft. S. T. fuse, at 45 cts. per 100	5.85
300 short electrical exploders, at 6 cts.	18.00
Total	$161.10

The total cost for the 4 acres was $256.10, giving a cost per acre of $64.02.

The cost per stump was:

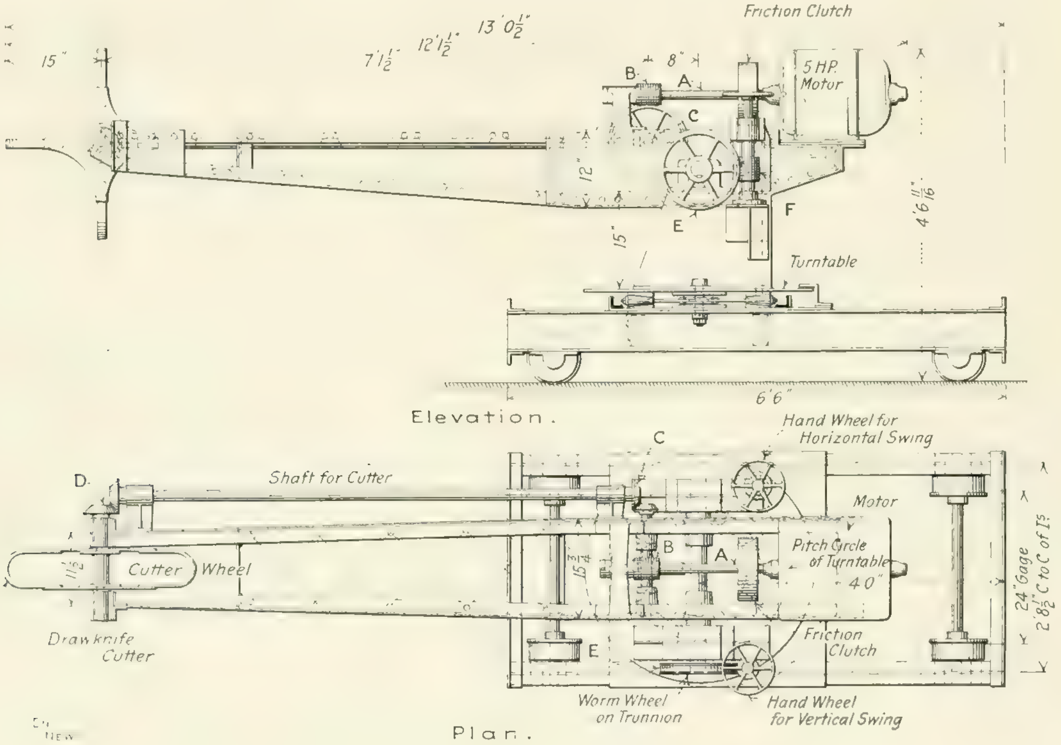
Labor	$0.086
Dynamite	0.116
Caps	0.009
Fuse	0.005
Exploders	0.016
Total	$0.232

The average amount of dynamite used per stump was 0.77 lb.

This is a very economical job of blasting, both as to labor, costs and explosives.

We are indebted to Mr. Oscar Kissam, of Halesite, Long Island, N. Y., for these data. The work was done under his direction and according to his methods.

The Russian Council of Empire has granted a concession for the construction of a railroad across the Donetz region northward 560 miles. The line is to cost $40,500,000, and the bonds, paying 4 per cent, will be guaranteed by the state and quoted on the Paris Bourse. The concession is owned by a syndicate composed of five French banks. This is the first guaranteed private railroad to be built in Russia since 1884.



Drawing Showing Construction of Tunneling Machine.

A Tunnel Excavating Machine for Soft Material.

The accompanying cut illustrates a tunneling machine invented and used by Mr. Geo. W. Jackson, of Chicago, Ill. Mr. Jackson has built more than 60 miles of tunnel, 5x7½ ft. in section, for the Illinois Tunnel Co., under the city of Chicago, and he is at present engaged in building some extensions to this system of tunnels, and some larger tunnels for the city for water supply. This work is in the stiff blue clay that is found underlying the city of Chicago, and, to excavate it, draw knives in the hands of men have been used to a great extent.

In this machine a knife is used, but it is now operated by electricity. As will be seen, the machine is mounted on a truck, the boom carrying the knives being on a turntable on the truck or car. The turntable allows of a horizontal swing, while the pivoting of the boom on the turntable allows the cutting end to be raised and lowered. The 5 h. p. motor operates the cutting knives, while the whole machine can be fed forward either by jacks or by a motor and gearing.

The excavated material falls upon a conveyor, which is entirely separate from the excavating machine. This conveyor delivers the material to another conveyor passing under the machine and loading into cars.

The whole machine is very simple in its design and operation. The cutting knives are the same shape as those used by hand. By substituting picks for the knives the machine can be adapted to coal mining. It is also used as a loading machine for sand, gravel and other materials by equipping the wheel with buckets.

The following table gives the highest daily records of steam shovels in the four construction districts of the Culebra division of the Isthmian Canal. Department of Excavation and Dredging for the month of April, 1908:

Shovel No.	Date.	Location.	Amount of material removed (cu. yds.)	Kind of material.
216	Ap. 9	Empire	2,780	rock and earth
124	Ap. 6	Empire	1,608	rock
215	Ap. 6	Bas Obispo	2,904	earth
127	Ap. 23	Bas Obispo	2,076	rock and earth
202	Ap. 9	Pedro Miguel	2,600	earth
123	Ap. 22	Pedro Miguel	1,469	earth
222	Ap. 8	Culebra	2,612	rock and earth
152	Ap. 9	Culebra	1,704	rock and earth

Shovels in the one-hundred class are 70-ton shovels with buckets of a capacity of 2½ cu. yds. Shovels in the two-hundred class are 95-ton shovels with dippers of a capacity of 5 cu. yds. The shovels are under steam for eight hours per day, but are not actually worked during this entire period, time being lost by the necessity of moving the shovel forward, blasting stone too big for the shovel to handle, keeping the shovel supplied with cars, etc.

Roads and Streets Section

Note: This Section is devoted to methods and costs of road and street construction. It will cover road building in all its details, the construction of pavements, sidewalks and gutters, the testing and use of paving materials and the machinery and tools used in road building and paving.

Data on Tarvia Road Treatment in New York State and Tar Macadam Work in Canada.

The Massachusetts Highway Commission has for some time been making a careful study with reference to preserving roads from the excessive wear due to automobiles and other traffic. The commission has conducted several road treatment experiments on the state roads, and in 1907 employed an engineer, Mr. H. C. Poore, to visit several points in New York state and Canada to see what had been done in those localities along that line. In New York state Mr. Poore had opportunity to see the tarvia process in several places and some of the oil treated roads, as well. The object of the trip to Canada was to inspect the tar macadam roads which have been built there for a number of years and which were constructed long before automobiles became so common. In the last annual report of the Highway Commission Mr. Poore reports at length on the processes employed in the localities visited by him, and the matter in this article has been taken from his report.

TARVIA WORK IN NEW YORK STATE

Queens County, Long Island.—The length of roads treated was 5 miles, for an average width of 23 ft. The process here includes patching the surface of the road with stones ranging from ¾ to 1¼ inches in diameter and sweeping with the horse sweeper and hand push brooms in an attempt to remove all of the fine material. Small kettles of 75-gallon capacity are used, and a continuous process is secured by keeping a barrel of tarvia emptying into the kettle while the hot tarvia is being taken from it. The tarvia is spread from a hose of sufficient length to reach to the gutters. Three men on each side of the kettle spread the material with soft brooms, such brooms being used to reach to the bottom of the depressions, which less flexible brooms would pass over. The covering of stone screenings is applied within thirty minutes after the tarvia application, to prevent the tarvia from running to the gutters. A gang of four men is engaged in the work of spreading the stone, keeping pace with the kettle as nearly as possible. These men become very proficient in spreading, and a uniform coating results, without waste of material. The roller passes over the road but once.

Temperature of the tarvia, 180° F. Quantity per square yard, 0.6 gallons. Total cost per square yard, including all work and materials, $0.14.

One and one-half miles of road which were treated in June, 1906, were re-treated in June, 1907, the center portion receiving the usual application; the shoulders were not touched.

The wear of the tarvia has been uniform. The top course of stone protrudes and gives the wearing surface, and all depressions are well filled with tarvia and screenings. No scaling or breaking up is noticeable.

Buffalo.—This tarvia work was done on a newly resurfaced road the length of road treated being 3 miles. The stone was flushed with water and rolled, and then left for four hours to allow the moisture to dry out before the tarvia was applied. The surface was swept slightly, and a thin grade of tarvia, probably water-gas tar, was applied, from a tank wagon having a patent spreading apparatus. The capacity of the tank wagon is 500 gallons, the form being similar to a horizontal steam boiler, having a manhole on top, a fire box under the rear end, and a flue extending under the entire length. The tank is mounted on 36-in. wheels, having wide tires. The tank wagon was filled from tank cars on railway sidings. A second application of standard tarvia was then applied from the same tank wagon. The covering was limestone broken to pea size, spread by hand from piles, and was well rolled in.

Total quantity of tarvia per square yard, 0.5 gallons. Cost of tarviating per square yard, $0.08, including the covering, but not including any portion of the expense of resurfacing.

The surface was very spongy, probably because of a lack of rolling of the material used in resurfacing. The tarvia penetrated ⅛ in. into the road. Small areas in the road were crumbly, said to be due to the tarvia being burned in the tank wagons during its application. The limestone covering crushes quickly under the traffic, and the surface of the road is very dusty.

Hudson.—The road tarviated was an old limestone road which had been surfaced with trap rock one year before its treatment with tarvia. The length of road treated was ½ mile. The road was swept with hand brooms. The continuous process of keeping cold tarvia running into the 50-gallon kettle, while the hot tarvia was being applied to the road, was noticed here. Two men spread the tarvia with stiff brooms, as it was delivered from a hose, and it was covered at once with limestone broken to pea size, spread by hand from wagons. The center of the road was given a slight rolling, but the shoulders were not rolled.

Quantity of tarvia per square yard, 0.45

gallons. Cost per square yard, $0.058 for tarviating and covering.

The temperature of the tarvia varied, owing to the small capacity of the kettle, and the tarvia was therefore unevenly applied.

The limestone screenings used here for covering grind up very easily, and cause a dusty surface.

Albany.—At Albany no patching was done. The length of road treated was 13 miles. The road was swept with a street sweeper and the tarvia applied in two coats, the first of thin tarvia, followed immediately by an application of the standard tarvia. The use of tank wagons similar to those employed at Buffalo, with patent sprinklers and followed by two men with push brooms, proved to be an efficient process.

The sprinkler used here consisted of 2-in. piping, in the form of an inverted T, the upright leg being connected with the spigot of the tank, and of sufficient length so that the horizontal member was about 10 ins. from the road surface and parallel thereto. Holes 1/16 in. in diameter were drilled at frequent intervals in the horizontal pipe, and through these holes the tarvia was supposed to trickle, a valve in the upright pipe being provided to regulate the rate of flow; but by reason of the clogging of the small holes much trouble ensued, since the pressure, which was dependent solely upon the head of the tarvia in the tank, was not sufficient to force the tarvia through the holes, if, for any reason, its temperature fell much below 180° F. The sprinkler was of sufficient width to permit a strip of roadway 5 ft. wide to be treated at one time.

One-half of the width of the road was first treated and covered with screenings, after which the traffic was shifted and the other half treated. The covering was not rolled. The tank wagons were hauled by a traction engine from a tank car on the railroad siding.

Quantity of tarvia per square yard, 0.5 gallons. Cost per square yard, $0.09 for tarviating and covering.

The thin tarvia penetrated more than standard tarvia does, possibly a total of ¼ in., and the second application formed the usual coating over the road.

The road was in excellent condition, the tarvia well filled with screenings, and no worn-out places were in sight. No crumbly spots were noticeable.

A stretch of road ½ mile in length, tarviated in 1904, was re-treated in 1907. This section was similar to the new work in appearance, the worn places not showing through the second coat. The process of re-treating was similar to the process of original application.

Oyster Bay, Long Island.—The length of road treated was 5 miles and on this work the so-called "cold tarvia process," which is to all intents the same as the "thin tarvia" used at Buffalo and Albany, was used. The tarvia was of the consistency of standard tarvia when the latter is heated to 240° F. The road was sometimes swept, but not always. The tarvia was run onto the road from barrels set on skids in a wagon. Three or four barrels were allowed to drain into the wagon body, which was lined with tin, and the material was then collected in a funnel attachment at the rear, from whence it was spread on the road. The spreading was done with brooms, two men on each side, and the sweepings, or a thin coat of sand, were applied by hand for a covering. The covering was not rolled.

Quantity of tarvia per square yard, 0.4 gallons. Cost per square yard, $0.04, including all labor and materials.

The penetration was ¼ in.; the tarvia forms no coating over the road surface, and the broken stone gives the wearing surface at once. After ten months the material is said to lose its life and to crumble.

Jamaica and Flushing, Long Island.—The total length of road treated on Long Island was 70 miles. In these places oil had been used to a great extent on macadam roads, to lessen the dust. The oils were what are known as "ragland" (said to contain 30 per cent asphalt) and "residuum." The oil is spread from common 500-gallon sprinkling carts, filled from tank cars, which are delivered at the nearest siding to the work, the oil being run into the sprinkling carts by a syphon. The sprinkling apparatus is similar to that of a water sprinkler, and may be easily taken apart and cleaned.

Two applications are given to the half road width, and this is then covered with coarse sand to fully cover the oil. Traffic is then allowed on the side of the road so treated, and the other side is oiled.

Quantity of oil, 0.33 gallons to the square yard. Cost per square yard, $0.04, including all labor and materials.

The oil sometimes penetrates to a depth of 1 in., the penetration varying according to the condition of the macadam. The surplus fine material, washed from the roadway onto the shoulders, is sometimes used for covering in place of sand.

A mixture consisting of two-thirds of fuel oil and one-third of crude tar has been tried with success, at a cost of $0.04 per square yard. This material acts as a very heavy oil, filling the depressions between surface stones in the macadam.

The process of oiling lays the dust, and at the same time is supposed to bind the road material. It is not considered as a resurfacing material, and care is taken not to have an excess of loose covering spread as the oil does not hold it in place. It is said that in order to secure the best results it is necessary to oil the roads at the beginning of each year; but many of the roads have been oiled but once, and have received no further attention. This is probably due to the expense of the process, considering the short life of the treatment. The mixture of tar and oil appears to be a step toward a longer lived material.

TAR MACADAM WORK IN CANADA.

Ottawa.—At Ottawa tar macadam has been constructed since 1902, and in five years' time 2.61 miles of city streets, averaging about 32 ft. in width, have been built, at a cost per square yard varying from $1.24 to $1.57. These streets were built as follows: On the subgrade is laid a rough stone foundation, very similar to the V-drains built on Massachusetts State highways, from 10 to 12 ins. thick; 3 ins. of 2½-in. broken stone, neither tarred nor heated, is spread and rolled on this foundation; then a 3-in. layer of 2-in. broken stone, heated and coated with hot tar, is laid and rolled; then a 1-in. layer of ⅝-in. broken stone, tarred and heated, is spread with rakes and rolled; and finally a thin layer of limestone dust is spread. The first four courses are rolled with a 15-ton roller, and the upper course with a 5-ton roller. The thickness of the above-described courses is in all cases the thickness after rolling. The specifications require that all stones which are to be tarred shall be absolutely clean, and that the stones shall not be heated too hot to be held in the hand, so as to prevent the burning of the tar.

During 1902 and 1903 tarring was done in a crude manner by pouring the tar over a pile of stones; but this proved to be too costly and unsatisfactory, as the stones were not thoroughly coated. In 1904 a concrete mixer was bought, and this is now used in mixing the 2-in. stones and tar, with better results and at a less cost. The ⅝-in. stone is tarred in an asphalt mixing plant located about one mile from the work. The macadam laid in 1902 appeared to be in the same condition as that laid in 1906. The top course had not worn through, and the ⅝-in. stone, with its tar coating, gave a clean, dustless surface, with sufficient roughness for foothold. The tar had not lost its resiliency, and was still adhesive.

In making repairs exactly the same quality of material as in the original work is used in any needed spot, and tamped thoroughly, allowing ½ in. to provide for shrinkage.

Toronto.—Between 1900 and 1906 5.7 miles of city streets, averaging 32 ft. in width, were constructed with tar macadam. Here, on the subgrade, 5 ins. of stones, ranging from 1¼ to 1¾ ins. in diameter, are laid, bound with gravel, wet and rolled. The next course consists of 3 ins. of 1-in. stone, heated to 225° F., and coated with tar before spreading. The upper course consists of ¼-in. flush coat of asphalt, with stone chips to fill the voids in the second course and to provide a wearing surface. Sometimes 1 in. of 1-in. tarred stones, with a sprinkling of screenings, is used in the upper course instead of the asphalt. The thickness of the above courses is the thickness after rolling.

The tarring mixture consists of three parts of tar to one part of pitch, heated to 200° F.; or refined tar is sometimes used, the proportion for either of the above being 150 lbs. of the tar to 2,000 lbs. of stone. It appears that the exact proportion in mixing the tar and the stone was not always followed, the usual method being to pour tar over a pile of broken stone and mix with shovels.

The stone to be tarred was frequently overheated, thus causing the tar to be burned. The result is that in spots the surface has crumbled. The method of repairing these areas is to clean out the old material and fill the spaces with fresh material.

Refined tar or tarvia, in the place of crude tar and pitch, is believed to give more reliable results. The 1-in. stone appears on the surface, firmly bound in by tar, and no raveling is noticeable.

Cost per square yard, $1.50. Cost of resurfacing ½ mile with 2-in. tarred stone and top dressing, $0.90 per square yard.

At the present time the low cost of asphalt ($1.50 per square yard) has caused tar macadam construction to be suspended. This low cost is due to the purchase by the city of a $30,000 asphalt plant, this being installed near the center of the city.

Hamilton.—Tar macadam has been constructed here at least as far back as 1880, and to date the total mileage is approximately 9 miles, of an average width of 30 ft.

On the sub-grade are placed large stone fragments, apparently but little attention being given to the sizes of the stones; then 3 ins. of 2½-in. hand-broken stones, heated and tarred, are laid; then 2 ins. of crusher-broken stone, of the 2½-in size, heated and tarred; then ¾ in. of fine gravel or quarry chips, tarred; then a thin top coat of screenings. The specifications require that the stones shall not be heated too hot to be held in the hand. In tarring the stones 8 gallons of tar are used to the cubic yard of 2-in. stones, and 20 gallons to the cubic yard of the ¾-in. stones, and the tarring is done by pouring the tar over the stones when they are in the piles.

The section of tar macadam laid in 1880 is still in existence, and, while there are many holes and depressions in the surface, some parts of the street are still in good condition.

The authorities there believe that the shifting and sliding of the lowest course causes the depressions, and that this may be remedied in future work by binding the large stones with gravel or small stones.

In 1899 the tar macadam cost $0.79 per square yard; in 1901, $1.06. The records of the cost of this work since 1901 were not available. Some of the work done in 1890 has recently been resurfaced with 3 ins. of tarred stone, at a cost of $0.25 per square yard.

A new process in repairing tar macadam streets is now being tried. The streets are patched and resurfaced with a ½-in standard asphalt top coating. This method was said to be very satisfactory, but no data concerning its cost were available.

GENERAL SUGGESTIONS AND RECOMMENDATIONS.

Tarvia Treatment.—For the tarvia treatment Mr. Poore considers that the large kettles used by the Massachusetts Highway Commission are better adapted for the work than the 50 and 75 gallon kettles used on some of the New York State work, because the effluent is likely to be more uniform in consistency, and there is less likelihood of the tar being burned while being heated. He also thinks that until some adequate spraying device, which will deliver the hot tarvia under sufficient pressure, is available, it is better to continue to flow the tarvia onto the roads, using some sort of a funnel attachment on the end of a hose which will deliver the tarvia in a broad, thin stream, than to attempt to sprinkle it on from tank wagons. Mr. Poore believes that the best covering for the tarvia is broken stone screenings, pea size, with the dust eliminated; and the next best covering is fine gravel or coarse sand. He also suggests that the tarvia in all cases should be delivered on the road surface at a temperature of 180° F. In Mr. Poore's opinion, on the work already done this degree of heat has not been reached, with the result that the penetration has not been so great as it should have been, and possibly more tarvia per square yard has been used than was necessary. He also recommends that in spreading the tarvia, brooms more flexible than those previously purchased should be used. That the covering should be spread in two coats: the first very thin, to be spread immediately after the tarvia is broomed, and only sufficient to prevent the flow of the tarvia to the roadside; the second application to be placed several hours later, with the sand-spreading machine, and in quantity sufficient to absorb all the tarvia then remaining on the surface. From his experience in Massachusetts and from his observations elsewhere Mr. Poore considers that the cost of tarviating should not exceed $0.08 per square yard for the original application.

Tar Macadam Construction.—Regarding tar macadam construction, Mr. Poore's report states: "It appears that the tar macadam roads in Canada are good for at least six years, with almost no repair costs; that the work there was done in a crude manner and without special attention to methods of construction or to the selection of materials, but that notwithstanding this the traffic appears to have little or no effect on the surface of the streets, and there is no complaint that the streets are slippery.

"I think it would be well, during the coming road-building season, to construct at least one section of State highway with the upper course of tar macadam. In my opinion, the lower course should be built in the usual way, except that it should be bound with broken-stone screenings or with sand, before the upper course is placed. The stones in the upper courses might well be coarser than is the general practice in the Massachusetts work, and might well range in size from those passing through a 2-in. ring to those which will not pass through a ½-in. ring. For a top dressing, an application of tarvia as a flush coat, with covering of pea stone or screenings, should be used. I consider that tarvia for the matrix would be better than ordinary coal tar, and that a concrete mixer might be used to advantage in coating the stones. The proportions of tarvia and stone adopted at Hamilton, Ont., might well be followed, unless in the progress of the work other proportions appear to be more satisfactory.

"In response to your suggestion, I give below my estimate of the cost of a road built in this manner, under Massachusetts conditions":

Assumptions.—Length of road, 1 mile; width, exclusive of shoulders, 15 ft.; average thickness, lower course, 3 ins.; average thickness, upper course, 2 ins.; sub-grade completed to receive macadam; cost of stone, delivered on the road, $1.25 per ton; cost of tarvia, delivered on the railroad, $0.075 per gallon.

Quantity of tarvia, Hamilton specifications, 8 gals. to 1 cu. yd., 6.4 gals. per ton 2 in. stone.

Estimate, 1 Mile of Tar Macadam.

Course No. 1, 30 tons to 100 ft., including binder:		
30 × 52.8 = 1,584 tons, at $1.25...		$1,980.00
Spreading (per ton)	$0.05	
Watering (per ton)	.06	
Rolling (per ton)	.12	
	$0.23	
1,584 tons, at $0.23.............		364.32
Course No. 2, 17.6 tons to 100 ft., not including binder:		
17.6 × 52.8 = 929 tons, at $1.25		1,161.25
Tarvia, 6.4 gals. per ton, 929 × 6.4 = 5,946 gals., at $0.075.........		445.95
Tarring, 8,800 sq. yds., at $0.02..		176.00
Spreading (per ton)	$0.05	
Rolling (per ton)	.12	
	$0.17	
929 tons at $0.17................		157.93
Tarviating, .4 of a gallon per square yard:		
Tarvia, 8,800 sq. yds. × .4 = 3,520.		
Tarvia, 3,520 gals., at $0.075.....		264.00
Labor, 8,800 sq. yds., at $0.02....		176.00
Screenings, 2.4 tons per 100 ft., 2.4 × 52.8 = 126.7.		
126.7 tons, at $1.25..........		158.38
Spreading (per sq. yard)..$0.010		
Rolling (per sq. yard)...	.005	
	$0.015	
8,800 sq. yds., at $0.015..........		132.00
		$5,015.83

20 per cent contractor's profit and use of machinery	1,003.17
	$6,019.00

$6,019 ÷ 8,800 equals $0.685 per square yard.

Following is an estimate for 1 mile of macadam road, using the same assumptions, with the exception that dust instead of tarvia is used for the binder, and no flush coat of tarvia is used.

Total quantity of stone, including binder, 50 tons per 100 ft.

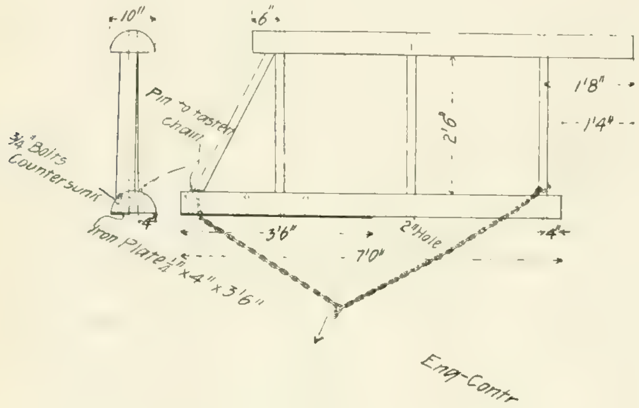


Fig. 1—Plan and Elevation of Split Log Drag.

50 × 52.8 = 2,640 tons, at $1.25.		$3,300.00
Spreading (per ton)	$0.05	
Watering (per ton)	.06	
Rolling (per ton)	.12	
	$0.23	
2,640 tons, at $0.23.............		607.20
		$3,907.20
20 per cent contractor's profit...		781.44
		$4,688.64

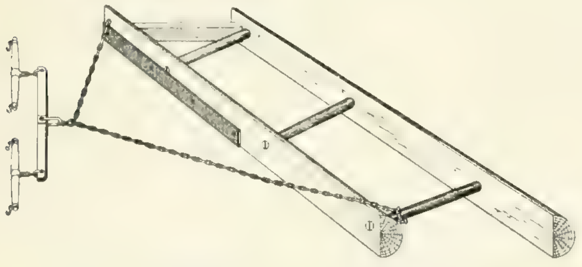


Fig. 2—Perspective View of Split Log Drag.

$4,688.64 ÷ 8,800 equals $0.533 per square yard.

Comparing the foregoing estimates, it would appear that the tar macadam road will cost 15.2 cts. per square yard more than the ordinary macadam road, and 7.2 cts. per square yard more than the macadam road built in the usual manner and tarviated afterwards.

The consumption of Indian coal in 1907 was 9,363,000 tons. The railways consumed about one-third of this, or 3,300,000 tons.

Methods of Dragging Earth Roads.

Excellent work is now being done in resurfacing and maintaining earth roads with drags. This tool, see Figs. 1 and 2, has been used for some years, but it remained for Mr. D. Ward King, of Missouri, to show by persistent work, the great use and importance of the log drag. A drag of this kind can be made from a log, split into two pieces. The drag should be light weight, and the chain so attached to it that it will be pulled at an angle. An earth road can be maintained at a small cost with this tool. The road should not be dragged when dry. In the summer time and early fall, the work should be done while it is raining, and the road should not be used until it has dried out. When the earth clods or crumbs up it is a sign that it is too dry. When the road is sloppy is the time that the best work can be done on the drag. In the winter time the road should be dragged just before a freeze. The work should be started on inside of the road and the drag be pulled back on the other side, thus working from the outside of the road towards the center.

A crown can be given the road with the drag. It may be necessary to go over the road several times if it is full of ruts. A board should be laid on the drag for the driver to ride upon and the depth of cutting can be regulated by his movements upon the plank. The driver should be alert and watch the ground continuously. The team should move in a walk. If the drag cuts too deep the hitch should be shortened.

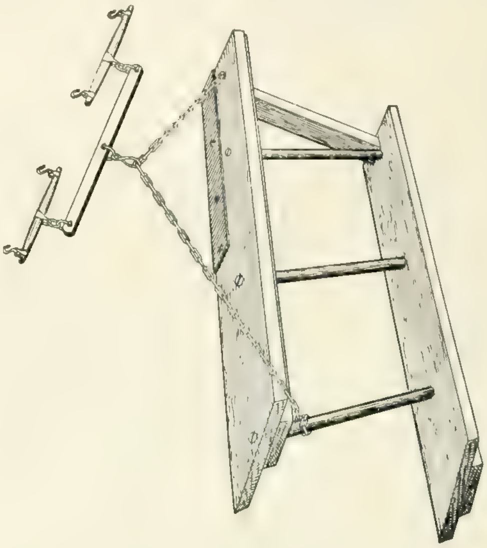


Fig. 3—Perspective View of Plank Drag.

A plank drag is shown in Fig. 3. This drag made from planks has a straighter edge than the log drag and the edge can be better protected with sheet iron. It can drag a square timber behind it or not as the operator wishes. This timber will be found of assistance in smoothing the mud that passes under the drag. Such a drag is manufactured by the Wm. S. Baker Co., of Indianapolis, Indiana.

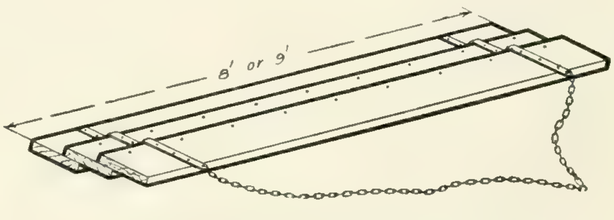


Fig. 4—Sketch of Lap Plank Drag.

Another form of a drag is illustrated in Fig. 4, known as the lap plank drag. This form has been used very successfully on extremely bad roads where the mud is very deep. It acts a great deal like a mason's trowel in smoothing out mortar, by spreading out the mud in a thin layer.

Road dragging is now being done in many sections of the country. In some parts of Canada there have been carried on drag contests among road builders and the farmers. In some states laws have been made regarding road dragging, the state engineers having drawn up rules for the guidance of men doing the work. The Highway Department of the State of Illinois have issued such rules in connection with laws passed by the legislature on dragging roads.

In connection with this drag there is used a ditch cleaner, which was described and illustrated in our issue of May 6, p. 290. There is also given in the same issue some cost data on dragging earth roads.

The expenditure of $30,000,000 for public buildings has been authorized by Congress.

Water-works and Sewer Section

Note: This section is devoted to methods and costs of constructing sewers and water-works. It will cover the construction work for all details of water supply and sewerage, including sewage purification and water filtration.

Method and Cost of Building a Pipe Sewer Through Quicksand, Excavating the Ground With a Pump, Showing Remarkable Economy.

Wild Wood is a new summer resort town, built a few years ago on the southern end of an island called Five Mile Beach, on the New Jersey coast. Prior to the building of the town the site was covered at high tide by 3 ft. of water. The soil was black mud covered with thick meadow sod, with, here and there, piles of sand which were shifted by the tide. The first work done was to build a bulkhead and by means of dredges to raise the land above the high tide. Then the building of the town and resorts began.

To serve the buildings a system of terra cotta pipe sewers was built. The trench for the entire distance, 12 miles, was through quicksand, from which water bubbled, and known locally as "boiling sand." This makes both expensive and difficult work, adding to the cost of laying the pipe, as it is difficult to keep the pipes at the proper grade and in good alignment, and the joints are hard to caulk, owing to the water in the ditch.

The greatest cutting was 6½ ft. deep and the entire trench was double sheeted throughout, great trouble being experienced in keeping the trench even partially dry. Sumps or wells could not be made, as the pumps pulled out so much sand under the sheeting as to cause the ditch to either fill or the sheeting to cave in.

The sheeting was put down to a depth of 10 ft. with a water jet in advance of the excavation, this being the only way the contractor could make any headway. Owing to the numerous "salt holes" encountered, through which the line at times ran, it was necessary to make a foundation for the manholes and pipe. This was done by piling spaced 7 ft. apart and 6 in. c. to c. On the piles 4x4 yellow pine 8 ft. long was spiked, and to this was spiked hemlock planks 2x8—12 ft. long. The pipe was laid on this and the hole filled with sand and salt hay.

If a manhole was located at one of these "salt holes," 4 piles, 10 to 15 ft. long were driven 4½ ft. c. to c. Four railroad ties were then spiked together with two pieces of batten, and the whole bolted securely to the piles. On this foundation was placed a box 5 ft. square and 10 ins. deep, the bottom being covered with tongue and grooved floor boards, and in some cases lined with canvas and the inside covered with coal tar pitch. The concrete was placed in the box, the pipe line run through and the brick work completed.

As a general rule water was struck in excavating the trench about 18 ins. below the surface. The pipe laid was 8 and 12 in. terra cotta, hence the ditch was made only wide enough for a man to work in it easily, this width being 2 ft. for a ditch 6 to 7 ft. in depth.

The method of excavating was as follows: By using the piston pump the sheathing was put down for a distance of 150 ft. along the trench, and a closure made at each end. Then 10 laborers were put in the trench and excavation made to the water line, when rangers and braces were set.

The piston pump was then started pumping water into this "land coffer dam." A centrifugal pump was moved into position and the discharge pipe placed midway in the last section, where the sewer pipe had already been laid. Thus the centrifugal pump excavated the material from the forward section and back filled the last section at the same time. See Fig. 1.

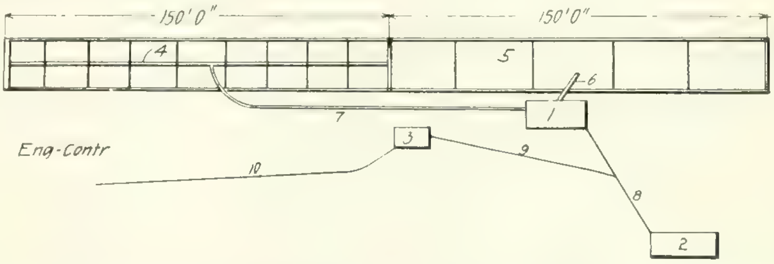


Fig. 1—Sketch Showing Layout of Plant.

(1) Centrifugal pump and engine on truck; (2) Boiler, (3) Piston pump; (4) Trench with pipe laid ready for filling, (5) Trench ready for excavation, (6) Suction pipe; (7) Discharge pipe; (8) Pipe, boiler to engine; (9) Pipe, boiler to pump; (10) Pipe to water supply.

When grade was reached the foundation piles were jetted down and the cradle constructed. The pipe was then laid, the joints being made with cement and tar. The next section was then done in the same manner.

The sand excavated was quite coarse, and but little agitation was necessary with shovels, in order to allow the pump to pick up the sand. When the sand is fine grained, much more water is needed, and likewise the sand must be agitated with shovels. With extremely fine sand, the men must be relieved frequently as the work is hard, and the pumps taking up a much smaller percentage of the sand means the ditch must be kept with a larger amount of water in it, and the men, being compelled to stand in the water, feel the effect of it quickly.

At times when the contractor got as deep in the trench as the original ground surface, he encountered a considerable number of roots that had to be cut out, but this was seldom necessary.

Fig. 1 shows the layout of the plant to do the work in the manner described. In this way an average of 300 lin. ft. of trench was dug and pipe laid per day, while another contractor doing similar work by another method averaged only from 35 to 50 ft. per day.

The cost of driving the sheeting and pulling it for the 300 lin. ft. of trench done per day was:

Boss timberman	$ 2.50
Fireman on jet pump	1.50
One man setting sheeting	2.00
Two helpers at $1.50	3.00
Three men pulling sheeting at $1.50	4.50
One man carrying sheeting	1.50
Two men bracing trench at $2.00	4.00
One man pumping	1.75
Coal and oil	1.00
Total	$21.75

This gives a cost per lin. ft. of trench of 7 cts. for driving and pulling sheeting, and as there was 6,080 lin. ft. of sheeting driven and pulled a day, it makes a cost per lin. ft. of sheeting 1-3 ct. With 2-in. sheeting used the amount of timber used was 6,000 ft. B. M., which cost $26 per M. This timber, being driven with a jet, was used time and time again. The sound piles, which were from 10 to 15 ft. long, cost 25 cts. a piece and the cost of driving them was 1.5 cts. per lin. ft.

The cradle for the pipe was built by two men each at $2 per day. They built 200 lin. ft. per day, which meant a cost per ft. of trench of 2 cts. The amount of lumber in 200 ft. of cradle was 866 ft. B. M., which meant a labor cost for framing of about $5 per M. The lumber cost $26 per M.

The daily cost of digging the trench and back filling, and of laying the pipe was:

Foreman, 10 hrs	$ 4.00
Eight men diggging at $1.50	12.00
Two men trimming, at $1.50	3.00
One engineman	3.00
One pumper	2.50
Two Pipemen at $2.00	4.00
Coal, at $5.00 per ton	1.25
Rent of boiler	2.00
Rent of pumps	2.50
Rent of engine	2.00

Two pipelayers, at $2.00...	4.00
Two pipe carriers, at $1.50	3.00
One man on mortar and jute	1.50
Total	$44.75

The excavation and back filling done by the pumper can be listed as follows:

Cost per lin. ft. of trench:

Labor	$0.032
Coal	0.004
Plant rental	0.022
Total	$0.058

Each day this plant excavated about 200 cu. yds., hence the cost per cu. yd. was:

Labor	$0.047
Coal	0.006
Plant rental	0.032
Total	$0.085

This is a very low cost for excavating earth from a trench and back filling it.

The terra cotta pipe cost 16 cts. per lin. ft. and the hauling of it cost 2 cts.

The total cost per lin. ft. of pipe laid was as follows, exclusive of manholes:

Foreman		$0.013
Excavating and backfilling by hand		0.050
Excavating and backfilling by pump:		
Labor	0.032	
Coal	0.004	
Plant rental	0.022	0.058
Driving sheeting		0.040
Bracing trench		0.013
Pulling and carrying sheeting		0.020
Piles in place		0.105
Cradle, lumber and labor		0.132
Pipe		0.160
Hauling pipe		0.020
Laying pipe		0.028
Materials for joints		0.013
Total		$0.652

This cost does not include any allowanc for general expense nor for the materials used in shoring the sides of the trenches. The sheeting was used many times, as driving the planks with a water jet did not injure the planks or break them up.

The cost of a manhole was as follows:

Cover and frame	$ 9.00
Brick layer	2.00
Bricks, 1,500 at $10 per M	15.00
Stone, ¾ cu. yd., at $1.00	.75
Cement, 3 bags at 50 cts	1.50
Pumping	1.12
Labor, excavating	3.18
Sheeting, etc	2.17
Total	$34.72

The cost of this work in a ground dificult to excavate is exceedingly low, and can be attributed to the metheds used in carrying on the work.

Mr. George L. Watson, M. Can. Soc. E. C., was chief engineer of the Wildwood Sewer Co., and designed the entire improvement made, including the sewers. He afterwards associated himself with the contractor for the sewers. Mr. Alexander Murdock; and, as engineer in charge, decided upon and put into operation the method used.

Railway Section

Note: This section is devoted to methods and costs of constructing railways. It will cover road-bed and track construction, contractor's plant and organization, surveying methods and permanent way structures.

Itemized Cost of the Stampede Tunnel (9,850 Lin. Ft.) and Its Masonry Lining.

The Stampede Tunnel on the Northern Pacific Ry. is 9,844 ft. long and was built in 1886 to 1888 by contract. The contract work included the excavation of this tunnel and the timber lining. Subsequently this timber lining was replaced with a masonry lining by the railway company's own forces. This article gives in detail the cost of the permanent masonry lining. To make the cost figures complete, however, we itemize the contract costs of the original construction as follows:

	Per Lin. Ft.
Excavation, standard section at $78	$78.00
Extra excavation, 3.2 cu. yds. at $4.50	14.40
Timber lining 305 ft. B. M. at $35	10.68
Traffic charges	0.77
Total	$103.85
Ballast	0.90
Track materials	1.23
Track laying	0.18
Track surfacing	0.16
Engineering	5.00
Total	$111.32

The above figures are the contract costs to the Northern Pacific Ry. Those who may be interested in knowing the conditions of the original work, the methods of construction adopted and the cost to the contractor will find them given in Gillette's "Rock Excavation—Methods and Cost."

The permanent masonry lining work, whose cost is given here, was begun June 16, 1889, and completed Nov. 16, 1895, the progress in lineal feet per year being as follows:

1889		1890		1891		1892		1893		1894		1895	
Walls	Arch	Walls	Arch	Walls	Arch	Walls	Arch	Walls	Arch	Walls	Arch	Walls	Arch
1,176	....	1,280	538	2,549	871	5,038	1,402	2,930	911	3,229	2,812	2,301	2,887

The side walls were of concrete and the arch was of brick, there being 30,259 cu. yds. of concrete side walls and 18,426 cu. yds. of brick arch, or a total of 48,683 cu. yds. of masonry lining in the 9,311 lin. ft. that were lined. There were, therefore, 3¼ cu. yds. of concrete side walls and 2 cu. yds. of brick arch, or a total of 5¼ cu. yds. per lin. ft. of tunnel.

The average cost of the lining was as follows:

Concrete side walls:

	Per Cu. Yd.	Per Lin. Ft.
Cement at $2.90 per bbl	$4.27	$13.95
Rock at 31c per cu. yd	0.24	0.80
Sand at 21c per cu. yd	0.12	0.40
Traffic charges	0.35	1.13
Train service	0.96	3.12
Labor	2.10	6.87
Falsework	0.08	0.27
Tools, lights, etc	0.10	0.33
Engineering and supt	0.16	0.53
Total	$8.38	$27.40

Brick arch:

	Per Cu. Yd.	Per Lin. Ft.
Cement at $2.90 per bbl	$ 2.93	$ 5.80
Brick at $7.12 per M	3.56	7.04
Rock backing at 59c per cu. yd	0.41	0.81
Sand at 40c per cu. yd	0.14	0.27
Traffic charges	0.36	0.71
Train service	1.21	2.39
Labor	4.20	8.32
Falsework	0.22	0.43
Tools, lights, etc	0.21	0.41
Engineering and supt	0.25	0.50
Total	$13.49	$26.68

Since the concrete side walls cost $27.40 per lin. ft. and the brick arch cost $26.68, the total cost was $54 per lin. ft. of tunnel, which, if added to the $111 above given, makes a grand total of $165 per lin. ft. Had the masonry lining been built in the first place, the cost would have been considerably less.

The item of "traffic charges" covers freight on materials at 1 ct. per ton-mile. The item of "train service" covers hauling of sand, rock, etc., with a work train.

The cost of this lining was very much higher during the first years of the work. This was due partly to the greater thickness of the lining used at first, but it was principally due to the inexperience of the men and the higher cost of materials. The following table shows the cost by six month periods:

	Brick Arch.		Concrete Wall.		
6 mos. ending –	Lin. ft.	Cost per lin. ft.	Lin. ft.	Cost per lin. ft.	Total per lin. ft.
June 30, 1889	..	..	33	$61.72	..
Dec. 31, 1890	..	..	1,143	61.72	..
June 30, 1890	257	$63.24	..	..	$124.96
Dec. 31, 1890	281	63.24	1,280	56.92	120.16
June 30, 1891	600	51.64	733	40.94	92.58
Dec. 31, 1891	271	51.64	1,816	40.94	92.58
June 30, 1892	517	34.90	2,422	22.06	56.96

Dec. 31, 1892	885	27.13	2,616	19.80	46.93
June 30, 1893	496	25.35	2,219	19.48	44.83
Dec. 31, 1893	415	20.96	711	19.40	40.36
June 30, 1894	904	20.21	3,229	16.55	36.76
Dec. 31, 1894	1,898	19.40	..	..	..
June 30, 1895	1,225	18.90	2,187	18.04	36.94
Dec. 31, 1895	..	..	114		.
Total	9,311		18,503		

The foregoing shows the progressive decrease in the cost per lineal foot. The following table shows the decrease in the cost per cubic yard:

	Brick Arch.		Concrete Walls.	
Six mos. ending—	Cu. Yds.	Cost per cu. yd.	Cu. yds.	Cost per cu. yd.
June 30, 1889.	..	..	83	$12.26
Dec. 31, 1889.	..	..	2,876	12.26
June 30, 1890.	617	$26.35	.	.
Dec. 31, 1890.	674	26.35	3,224	11.30
June 30, 1891.	1,740	17.90	1,303	11.51
Dec. 31, 1891.	786	17.90	3,228	11.51
June 30, 1892.	1,092	16.53	3,582	7.33
Dec. 31, 1892.	1,634	14.69	3,488	7.42
June 30, 1893.	916	13.72	2,951	7.32
Dec. 31, 1893.	751	11.58	1,139	6.05
June 30, 1894.	1,645	11.10	4,720	5.66
Dec. 31, 1894.	3,479	10.55	..	..
June 30, 1895.	2,322	10.21	3,495	5.64
Dec. 31, 1895.	2,770	..	170	..
Total & av.	18,426	$13.49	30,259	$ 8.38

The cost of lining the tunnel during the six months ending Dec. 31, 1892, represents about an average of the whole job. It was as follows:

Concrete side walls:

Materials:	Per Cu. Yd.
Cement, 1.5 bbls. at $2.36	$3.54
Sand, 0.33 cu. yd. at 36c	0.12
Rock, 0.5 cu. yd. at 55c	0.28
Dry rock backing, 0.04 cu. yd at 55c	0.02
Total	$3.96
Traffic charges:	
Cement	$0.24
Sand	0.17
Rock	0.18
Total	$0.59
Work train service:	
Hauling concrete, removing old timbers and excavated material, 0.031 day of work train, at $26.90	$0.83
Labor:	
Mixing cement dry, 0.104 day, at $2.50	$0.26
Building walls, 0.247 day, at $2.84	0.70
Removing timbers, excavating and preparing panel for concrete, 0.226 day, at $2.83	0.64
Placing rock backing, 0.02 day, at $2.50	0.05
Total	$1.65
Engineering, supt. and miscell.:	
Engineering	$0.29
Falsework, timber and iron	0.06
Lights, wear on tools, etc	0.03
Interest and deprec. of plant, 10 per cent per annum on $1,500, for 3½ mos.	0.01
Total	$0.39
Total per cu. yd. in place	$7.42

The proportions were 1 cement, 3 sand and 5 rock. The dimensions of each side wall were 2 ft. 3 ins. thick and 16 ft. high. There were 1.33 cu. yds. of concrete per lin. ft. of side wall, or 2.66 cu. yds. per lin. ft. of tunnel. The average daily force, not including the work train crew, was:

1 foreman at $135 per mo.
1 foreman at $3.75 per day.
1 foreman at $3.25.
3 carpenters at $3.
22 laborers at $2.50.
4 laborers at $2.

The average daily progress was 38.75 cu. yds. per day.

The average daily force "building the side walls" was:

1 foreman at $135 per mo.
2 foremen at $3.25 per day.
4 carpenters at $3.
12 laborers at $2.50.

The average daily force engaged in "removing timbers, excavating, etc.":

1 foreman at $135 per mo.
2 foremen at $3.75 per day.
2 carpenters at $3 per day.
14 laborers at $2.50 per day.

The cost of the brick arch during the same period was:

Brick arch:

Materials:	Per Cu. Yd.
Brick, 526, at $7 per M	$3.68
Cement, 1.18 bbls., at $2.40	2.83
Sand, 0.263 cu. yd., at 82c	0.21
Dry rock backing, 0.483 cu. yd., at 75c	0.36
Total materials	$7.08
Traffic charges:	
Brick	$0.89
Cement	0.19
Sand	0.13
Total	$1.21
Work train service:	
Hauling brick and cement and removing debris, 0.046 day, at $26.70	$1.23
Labor:	
Mixing mortar and building arch, 0.78 day, at $4.06	$3.16
Placing rock backing, 0.135 day, at $2.66	0.36
Moving centers, preparing for work and removing timber, 0.383 day, at $2.87	1.10
Total	$4.62
Engineering, supt. and miscell.:	
Engineering and superintendence	$0.44
Falsework, timber and iron	0.05
Changing lights, wear on tools, etc	0.04
Interest and deprec. of plant, 10 per cent per annum on $1,500, for 2½ mos.	0.02
Total	$0.55
Total per cu. yd	$14.69

The brick arch was 5 rings thick, or 1 ft. 9 ins., and 28½ ft. around the arc. The bricks were 2⅛x3⅞x8 ins. There were 1.85 cu. yds. of brick masonry per lin. ft. of tunnel, making the cost $27.13 per lin. ft. for the brick arch. The average daily progress was 25.9 cu. yds., with the following force, not including work train crew:

1 foreman at $135 per mo.
1 brick mason foreman at $6.50 per day.
1 foreman at $3.75 per day.
1 foreman at $3.25 per day.
7 brick masons at $6 per day.
3 carpenters at $3 per day.
25 laborers at $2.50 per day.

The average gang engaged in "mixing mortar and building arch" was:

1 foreman at $135 per mo.
1 foreman at $3.75 per day.
2 brick foremen at $6.50 per day.
7½ brick masons at $6 per day.
1 carpenter at $3 per day.
21 laborers at $2.50 per day.

The average gang engaged in "placing rock backing" was:

1 foreman at $135 per mo.
2 foremen at $3.25 per day.
4 carpenters at $3 per day.
30 laborers at $2.50 per day.

The average gang engaged in "removing timbers, excavation, etc.," was:

1 foreman at $135 per mo.
2 foremen at $3.75 per day.
5 carpenters at $3 per day.
12 laborers at $2.50 per day.

As above stated, the cost during the last year of the work was very much reduced.

During the six months ending June 30, 1895, the cost of lining was as follows:

Concrete side walls:

Materials:	Per Cu. Yd.
Cement, 1.33 bbls., at $2.25	$2.99
Sand, 0.47 cu. yd., at 18c	0.09
Rock, 0.79 cu. yd., at 39c	0.31
Total	$3.39
Work train service:	
Hauling concrete, removing debris and old timber, 0.022 day at $22.90	$0.51
Labor:	
Mixing cement, 0.07 day, at $2.14	$0.15
Building walls, 0.28 day, at $2.40	0.66
Removing timbers, excavating and preparing panel for concrete, 0.21 day, at $2.62	0.54
Total	$1.35
Engineering and miscellaneous:	
Engineering and superintendence	$0.22
Falsework, timber and iron	0.06
Tools, lights, etc	0.10
Interest and deprec. of plant, 10 per cent per annum of $1,500 for 3 mos.	0.01
Total	$0.39
Total per cu. yd	$5.64

It will be noted that "traffic charges" (freight on the materials for concrete) appear to have been omitted.

The proportions of the concrete were 1:3:5. The side wall was 2 ft. 7 ins. thick by 16 ft. high, and each side wall contained 1.6 cu. yds. per lin. ft. The average progress per day was 46 cu. yds., and the working force was as follows:

1 foreman at $112.50 per mo.

1 foreman at $90 per mo.
1 foreman at $3.50 per day.
1 blacksmith at $3 per day.
2 carpenters at $3 per day.
19 laborers at $2.25 per day.
7 laborers at $1.75 per day.

The cost of the brick arch during the same period was as follows:

Brick arch:	
Material:	Per Cu Yd
Brick, 500 at $6.35.	$3.18
Cement, 0.98 bbl., at $2.25	2.21
Sand, 0.34 cu. yd., at 28c	0.09
Total	$5.48
Work train service:	
Hauling material, debris, etc., 0.037 day, at $24.25	$0.91
Labor:	
Mixing mortar and building arch, 0.57 day. at $3.15	$1.80
Placing rock backing, 0.09 day, at $2.29	0.21
Removing old timbers, excavating and preparing for arching and moving centers, 0.32 day, at $2.48	0.80
Total	$2.81
Engineering and miscellaneous:	
Engineering and superintendence	$0.23
Falsework, timber and iron	0.09
Tools, lights, etc	0.20
Interest and deprec. of plant, 10 per cent per annum on $1,500 for 3 mos.	0.02
Total	$0.54
Total per cu. yd	$10.21

It will be noted that the item of "traffic charges" appears to have been omitted.

There were 5 rings of brick in the arch, giving a thickness of 1 ft. 9 ins., and the length of the arc was 28 ft. There were 1.85 cu. yds. of brick masonry per lin. ft. of tunnel. The bricks were 2⅛x3⅞x8 ins.

The average progress per day was 44.2 cu. yds. with the following force:

1 foreman at $112.50 per mo.
1 foreman at $90 per mo.
1 foreman at $3.50 per day.
1 brick mason foreman at $5.50 per day.
8 brick masons at $5 per day.
1 carpenter at $3 per day.
1 blacksmith at $3 per day.
27 laborers at $2.25 per day.

The gang when engaged in "mixing mortar and building arch" was as follows:

1 foreman at $112.50 per mo.
2 foremen at $3.50 per day.
2 mason foremen at $5.50 per day.
1 time keeper at $60 per mo.
17 brick masons at $5 per day.
1 blacksmith at $3 per day.
25 laborers at $2.25 per day.

The gang when engaged in "placing rock backing" was as follows:

1 foreman at $112.50 per mo.
½ time keeper at $60 per mo.
½ blacksmith at $3 per day.
¼ carpenter at $3 per day.
22 laborers at $2.25 per day.

The gang when engaged in "removing old timbers, etc.," was as follows:

1 foreman at $112.50 per mo.
3 foremen at $90 per mo.
1 time keeper at $60 per mo.
3 blacksmiths at $3 per day.
1 carpenter at $3 per day.
17 laborers at $2.25 per day.

Structural Steel Section

Note: This section is devoted to methods and costs of constructing steel structures. It will cover tests of steel, shop work and erection, giving particular attention to erection plant, methods and costs for building and bridge construction.

Method of Erecting a Steel Bridge by Launching.*

BY C. N. MONSARRAT †

The new branch line of the Canadian Pacific Ry., extending from Romford, Ont., a point about six miles east of Sudbury, on that company's main trans-continental line, southerly to Bolton Junction, where it connects with the Owen Sound section, about 21 miles north of Toronto, includes a number of important bridges, one of the largest of which is that crossing the French River about 43 miles south of Romford.

This bridge is located at a point where the river has a width of approximately 550 ft., while the depth of the water for about three-fifths of the crossing averages 90 ft. The character of the bottom is rock, with about 10 ft. of soft mud overlying it. The current is, however, very slight, being only about 0.3 mile per hour.

In order to avoid the great expense of building a pier in the deep water, it was found necessary to locate the first pier 415 ft. south of the north abutment, where a good foundation was obtained in about 48 ft. of water. The dimensions of this pier are 9 by 30 ft. at the top under the coping, which is 2 ft. thick, with an overhang of 4½ ins. on all sides, and has a batter of 1 in 12 on each side for a depth of 30 ft., making the bottom of the shaft on the footing 14x30 ft., the ends being vertical. The foundation, or footing, is 21x33 ft. 10 ins. long by 40 ft. high; the total height of the pier is 72 ft., and it was designed to resist the tractive forces from the spans supported by it. There is a second and smaller pier located 67 ft. 2 ins. farther south in about 15 ft. of water, the shaft of which has a batter on each side of 1 in 24. The total height of this pier is 44 ft. and the dimensions at the top are 6x16 ft. under the bridge seat, or coping, which overhangs 3 ins. on all sides. The abutments at both ends are located at the water edge. The north abutment could not be built further south on account of the rock at this point, which is very steep on the west side.

In laying out the substructure three independent triangulations were made. Reference points were located on the tops of the hills on either side of the river, on three parallel lines, one along the center line and one at each end of the piers. These points were high enough to permit of an instrument being set up on one side and a foresight being taken on the opposite shore at any time during the progress of the work.

After the abutments and piers were located, they were checked by steel tape rigged as follows: A ring bolt was set in the rock at the north shore of the river directly on the center line of the bridge, and from this a ⅛-in. diameter steel cable was stretched across to the south shore and made taut by block and tackle. To prevent sagging of the cable, floats having their tops at exactly the same level as the ring bolt were anchored in the river at frequent intervals to support it. Rings were attached to this cable every 4 ft. and a 600-ft. steel tape passed through them.

The difficulties encountered in getting plant and material for the substructure to the site were exceptionally arduous. Everything had to be brought in from French River village on Georgian Bay, at the mouth of the French River. First, rapids had to be overcome, then a portage of a mile and a half, then the plant was again floated up the Pickerel River (which had its difficulties, too) a distance of 23 miles to what is called the Horse Shoe Falls. There the outfit was elevated some 25 ft., loaded again and transported some 12 miles over a swift and rough course to the bridge site.

Broken stone and sand used in making the concrete was hauled a distance of 12 or 15 miles through a wilderness by teams in winter. The contractor's plant consisted of the usual concrete outfit of picks, shovels, concrete mixer, blacksmithing outfit and other things incidental thereto; one submarine drill, complete for preparing the foundations; several sets of drill steel averaging 45 ft. in length, one 30-ft. high steel frame with sliding carriage for drill, truck wheels and operating platform. This outfit was operated by hydraulic pressure furnished by a large Worthington high pressure pump, having the necessary attachments and connections; two 30 h.p. boilers, two 32 h.p. hoisting engines with derricks and swinging gear complete, one 1¼-yd. orange peel bucket; two 20 h.p. hoisting engines with derricks; four large scows, 24 x60 ft., and two tugs; two sets of diving apparatus, in addition to many other odds and ends of machinery. The drilling machinery was placed on the scows, which were anchored at the pier sites. After holes were drilled, they were shot with dynamite, and the loose rock removed by means of the orange peel bucket, or a derrick with chains and grappling hooks at the bottom, until the foundation had been properly benched and leveled off. Holes were then drilled in the rock about 4 ft. apart, and 2-in. diameter steel dowels, 6 ft. long, set in them, and projecting about 3 ft. up into the concrete footing. The timber caisson for pier No. 1 was built about 48 ft. high and well reinforced with timber braces. Heavy canvas was attached around the bottom on the inside, and after the caisson was sunk into position, the divers went down and rolled this out. Concrete in sacks was then deposited around the edges to make it conform to the contour of the rock and so prevent any wash or current through the pier. Mortar of a consistency of one part of cement to two parts of sand was then deposited to the amount of 50 cu. yds., followed without any intermission by the work of concreting, which was carried on by means of bottom-dumping buckets. The concrete, up to water level, was mixed in proportions of one part of cement, two of sand and four of broken stone, and above water one part of cement, three of sand, and five of broken stone. Similar methods were followed in constructing the second and smaller pier.

---

* A paper read before the Canadian Society of Civil Engineers, April 16, 1908.

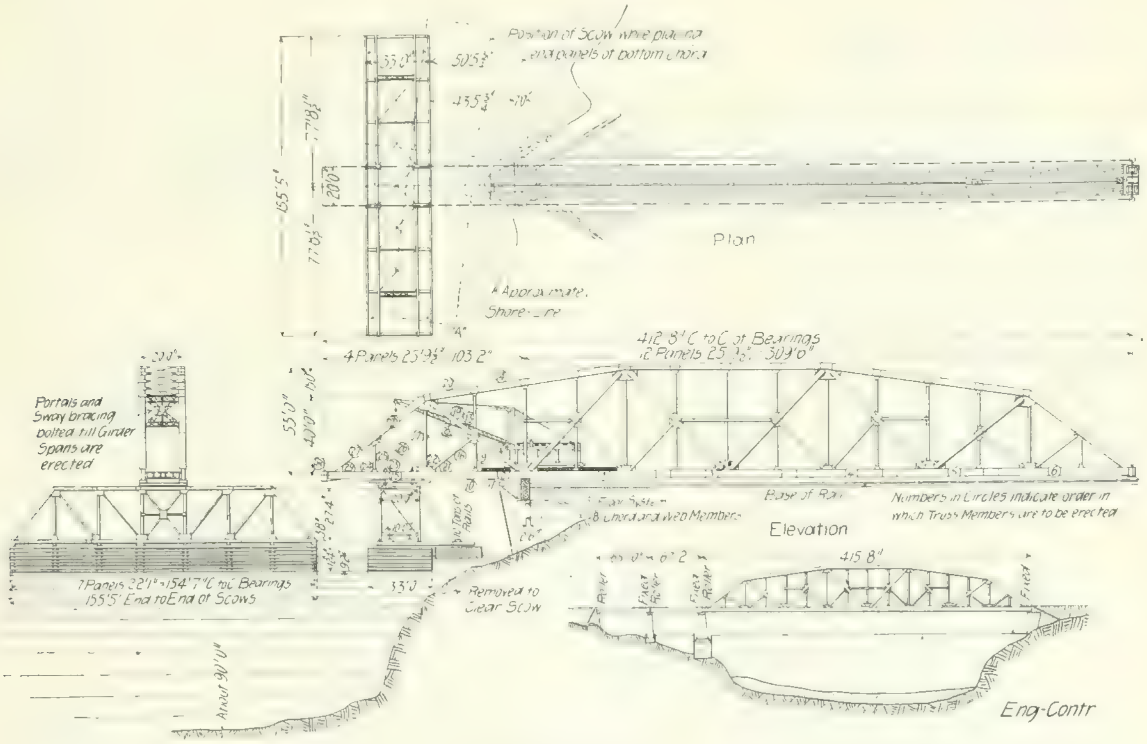
†Engineer of Bridges, Canadian Pacific Ry., Montreal, Canada.

The quantities of concrete in the substructure aggregate 3,020 cu. yds., as follows: North abutment, 913 cu. yds.; No. 1 or main pier, 1,421 cu. yds.; pier No. 2, 226 cu. yds.; and south abutment, 460 cu. yds.; rock excavation, 337 cu. yds.; earth, 141 cu. yds.

The above layout required one 415-ft. span, over the deepest part of the crossing, which was designed as a rivetted, subpaneled, through Warren truss with inclined top chords (weighing 2,563,362 lbs.) and two 60-ft. deck plate girder spans (weighing together 126,540 lbs.) over shallower water to the south abutment. The superstructure was designed in accordance with the requirements of Canadian Pacific Railway 1905 Specification, providing for a live load of two typical consolidation engines coupled together, weighing 337,000 lbs. each, followed by a uniform train load of 4,000 lbs. per lin. ft.

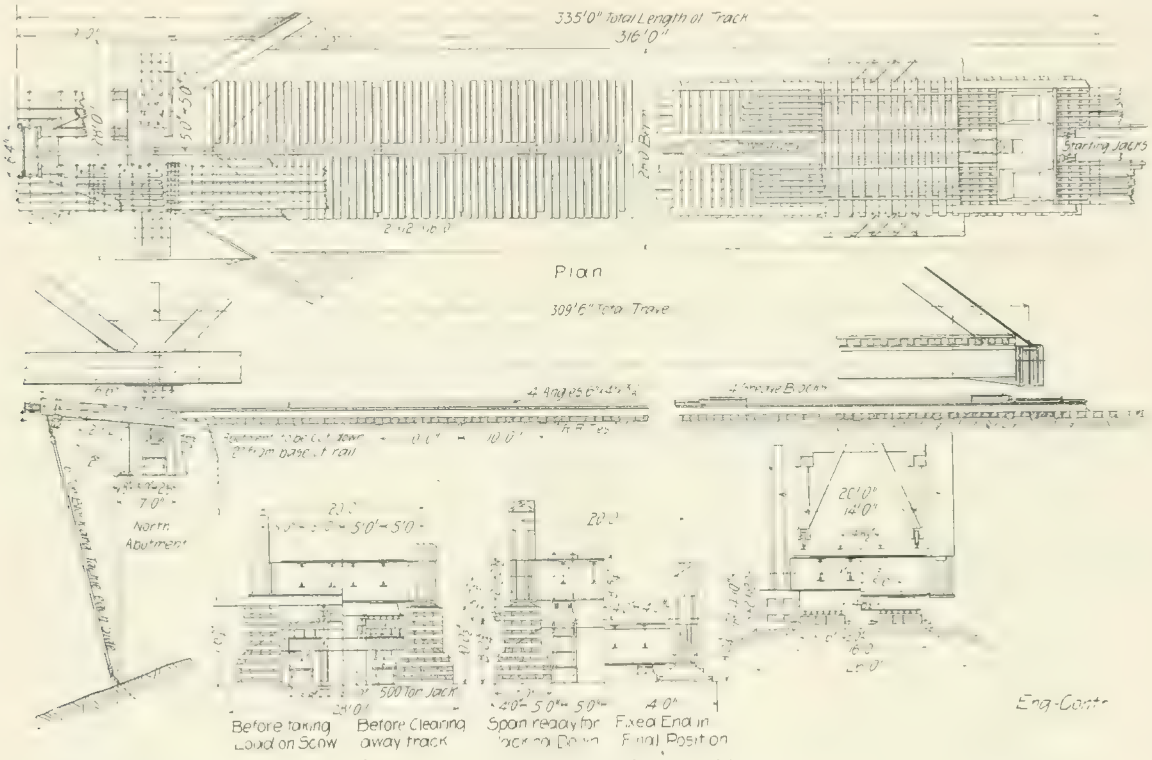
Probably the most interesting feature in connection with this work was the erection of the main truss span. On account of the great depth of water it was not possible to build falsework and erect the span in its proper place, so after due consideration of several possible schemes of erection it was decided to erect the span on the north approach embankment, on the center line of the bridge (produced) and launch it forward by supporting the forward end on a large scow, and sliding the rear or north end on a skidway of greased rails. This embankment, immediately north of the north abutment, was a new fill consisting mainly of boulders, coarse gravel and sand, with a maximum height of about 25 ft. against the abutment, running out to the natural surface of the ground about 100 ft. north. The width of the embankment at subgrade was 16 ft., and in order to provide a proper bearing for the skidway, it had to be widened to 25 ft. On this specially prepared roadbed two parallel skidways, about 316 ft. long, were built 10 ft. center to center, each consisting of railway ties about 15 ins. on centers, with a 12x12 timber 16 ft. long, every 10 ft., to tie the two skidways together. On these ties were laid five lines of 12x12 longitudinal timbers, over which was laid a flooring of 3x12 planks, supporting seven lines of 80 lb. rails, laid with joints staggered and securely spiked and bolted together.

The steel work was accordingly erected on the embankment, using a specially designed traveler, consisting of two 60-ft. boom derricks of 10 tons capacity each, mounted upon a timber framework designed to travel upon rails gauged 14 ft. centers, the platform of the traveler being placed 12 ft. 7 ins. above top of rail so that lorry cars, loaded with bridge material, could readily pass underneath on standard gauge railway track, and the material be picked up by the traveler booms. Each of the 60-ft. boom derricks was handled by separate double-drum Beatty engines, placed at the rear end of the traveler and forming part of the 20 tons of counterweight on each side required to provide for the uplift due to loading the boom derricks. The assembling of the span on the embankment was, in itself, quite a difficult operation, on account of the large size of the members to be handled, some of them weighing as much as 40 tons. Before any work was started, the order in which each member was to be erected was fixed and clearly shown on the erection diagram. In order to permit of supporting the forward end of the span by the scow it was necessary to erect it with its south end projecting over the water about 103 ft. The bottom chords and floor system, excepting that portion overhanging the water, were first placed in position by means of a self-propelling derrick car, ties were then laid for temporary track on the steel stringers, and the traveler erected with which the balance of the span was assembled.


Position of Scow while placing end panels of bottom chord
55'0"
50'5¾"
43'5¾"
155'5"
77'8½"
20'0"
77'0½"
Plan
Approximate Shore Line
"A"
4 Panels 25'9½" 103'2"
412'8" C to C of Bearings
12 Panels 25'9¼" 309'0"
20'0"
Portals and Sway bracing bolted till Girder Spans are erected
55'0"
40'0"
38'
27'4"
7 Panels 22'1" = 154'7" C to C Bearings
155'5' End to End of Scows
33'0"
Removed to Clear Scow
About 90'0"
Base of Rail
Numbers in Circles indicate order in which Truss Members are to be erected
Elevation
415'8"
Roller
Fixed Roller
Fixed Roller
Fixed
Eng-Contr

Plan, Elevation, End Elevation and General Profile of French River Bridge of C. P. Ry.

In placing the two end bottom chord sections on top of the stiffening span, it was necessary to place the scow in the temporary position shown in dotted lines on plate No. 1, so that they could be placed by the traveler, the forward trucks of which could not be run out beyond the panel point resting over the bridge seat on the abutment. To do this it was necessary to blast out some of the rock projecting out under the water, to clear the northeast corner of the scow. When these chords were placed the scow was returned to its correct position and the erection of the overhanging portion, as a cantilever, from the portion of the span previously erected upon the embankment, was proceeded with.


335'0" Total Length of Track
316'0"
Starting Jacks
Plan
309'6" Total Travel
4 Angles 6x4x¾
North Abutment
7'0"
5'0"–5'0"
500 Ton Jack
20'0"
14'0"
Before taking Load on Scow
Before Clearing away track
Span ready for Jacking Down
Fixed End in Final Position
Eng-Contr
Plan, Elevation and End Views of Abutments, Showing Skidding Track and Jacking Operations.

In order to place the scow at the proper elevation under the projecting end of the large span, it was necessary to depress it about 4 ft. by pumping in water. As this water ballast would render the scow unstable transversely until it took a bearing under the 415-ft. span, it was necessary to use a small balancing scow, which was placed at the north side of the large scow and secured to the latter and the stiffening span, by means of diagonal and horizontal struts, and was equipped with counterweight and adjusting screws to provide for any raising or lowering of the large scow. The general dimensions of the large scow referred to, which was built at the site, were: Length, 155 ft.; 33-ft. beam and 12 ft. deep; made in two sections for convenience in launching. It was built of 12x12 timbers for the ends; bulkheads and intermediate frames, 6x12; sheeting on the sides, 4x12 for the bottom, with joints staggered and secured to the framing with ⅝x12 lag screws. The bulkheads were spaced 22 ft. 1 in. center to center to conform with the panel points of the 150-ft. through riveted truss span, which was erected on the scow as a stiffening span, each panel point being blocked on a cross bulkhead. All seams in the sheeting, up to about 2 ft. above load water line, were caulked with oakum.

On completion of the assembling of the large span, the traveler was taken down, the ties used as temporary floor removed, and all field connections, excepting end portals and sway bracing, were riveted before launching was started. The field rivets, of which there were approximately 60,000, ⅞ in. diameter, were driven by means of pneumatic riveting hammers, a compressed air plant having been installed for the purpose.

The scow was equipped with boiler and double-drum hoisting engine, as well as a centrifugal pump with 8-in. suction and 6-in. discharge pipes, and a sluice arrangement located over the double bulkhead forming the ends of the two component parts of the scow by which the water pumped in could be controlled, and directed into either half of the scow. Each intermediate bulkhead had an 8x8 hole near the bottom so as to equalize the water in each compartment.

The load from the south end of the 415-ft. span, and the 150-ft. stiffening truss supported by the scow, was about 1,000 tons. The load from the north end of the span, amounting to about 640 tons, was transmitted to the skidway through the two large fixed end cast iron shoes (used temporarily for the purpose), placed 10 ft. center to center, under the end floor beam, which had been designed with a special view to such use. This arrangement of the castings left a clear space under the truss bearings for landing of the span on oak blocking over the bridge seats preparatory to its being jacked down to its bearings. The oak blocking was required for the temporary support of the span at an elevation about 8 ft. 5¼ ins. higher than its final position, this height being necessary to permit the skidway to pass over the parapet wall of the abutment. Before the aforementioned cast iron shoes and the skidway rails was placed a ⅞-in. steel plate, large enough to include both castings, with strips riveted to its under side to form guides to engage the rails on the skidway.

When the scow was in position under the overhanging end of the main span, in front of the north abutment and transverse to the center line of the bridge, two guide anchors were located on the opposite shore at an angle of 45 degrees. Holes were drilled in the rock and 3½-in. steel bars were grouted in a vertical position. To each of these anchors was secured a two-sheave steel block carrying four lines of ⅝-in. wire cable, forming the forward guy lines, which were wound up simultaneously on the drums of the hoisting engine, on the scow, as the span moved forward, steadying the floating end from any effect of wind or current.

The tackle used to haul the 415-ft. span into position consisted of two specially constructed steel pulley blocks, having 14 sheaves each, through which was reaved a ⅝-in. diameter steel wire cable 1,000 ft. long, with a fall line leading back to the drum of a hoisting engine located on the land at the north end of the skidway. This engine was a 32 h.p. Beatty double drum hoisting engine, with two cylinders, 8x12, boiler 41 ins. in diameter by 108 ins. high, and capable of pulling 8,000 pounds on a single line.

One of the large blocks was secured to the skidding plate under the castings, and the other to the rear end of a string of bottom laterals belonging to a 250-ft. through span designed for the crossing of the Pickerel River, a short distance south of the French, consisting of two angles 6x4x½ each, used as pulling links. These were in turn secured by a pin to a box girder supported by struts in front of the north abutment. Each section of these laterals was about 30 ft. long, and when the two large blocks were brought together one or two sets of lateral links were removed and the blocks overhauled. When the last section was reached it was removed, and the forward block secured by the pin direct to the box girder.

When everything was in readiness, on the evening of October 27, 1907, the scow was pumped out by means of the centrifugal pump, until the span was raised off the blocking. When this occurred it was found that there still remained a foot of water in the scow, showing that an ample margin of buoyancy had been allowed. At 8 a. m. on the 28th the engine was started, and with the assistance of a slight shove from two 40-ton hydraulic jacks the large span started on its way, moving on the well greased skidding rails at the rate of 4 to 6 ft. per minute. Considerable time was lost owing to the inability of the small boiler of the hoisting engine to keep up a sufficient steam pressure and also in the overhauling of the very heavy tackle.

The actual time occupied in moving the span was 3 hours, and in overhauling tackle, etc., 4 hours. The span was landed on its blocking at 4:05 p. m., without a hitch of any kind.

Trouble had been anticipated with settlement of the skidway on the new dump in view of the 640-ton concentrated moving load passing over it, but in no case was the settlement over 6 ins., and it was uniform at both sides, the greatest variation of the span from the level being about ⅛ of an inch in its width. So smoothly did the span move that it was possible to set it in its final location with the engine alone, without the assistance of jacks, and by means of the steering control afforded by the forward guy lines the span was within ¾ of an inch of its proper alignment when landed on the main pier on the south side of the river.

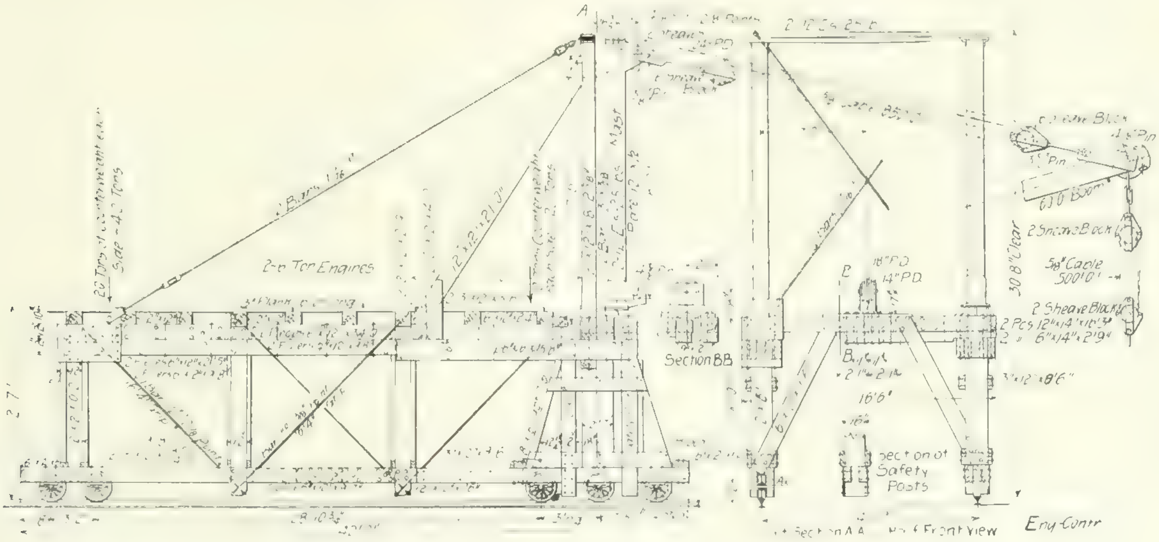
The lowering of the span to its final bearings on the bridge seats was accomplished by means of two specially constructed 500 ton hydraulic jacks. After the span was landed on the wooden blocking, the skidway castings and skidding plate were removed and cast steel cap plates were bolted to the under side of the floor beam, these plates being turned out to fit over a cast steel disc plate 23 ins. diameter by 3½ ins. thick, placed on top of the plunger of each jack; between the bottom edges of these discs and the shoulders of the jack cylinders were placed a number of ¼-in. steel plate half ring shims as a safety precaution against accident should anything go wrong with the jacks, in which event the weight would be transferred to the massive jack cylinders.

The jacks were each placed on blocking consisting of three super-imposed steel cylinders filled with concrete, over which were placed a number of cast iron cellular blocks 2 ft. 10 ins. in diameter by 3½ ins. thick. The ¼ in. shim plates were removed one at a time as the span was lowered so that in no case was there left a space greater than ¼ in. between the under side of the disc and the jack shoulders. Before the last of these shims was removed the span was landed on the oak blocking, the jacks released and one or more sections of cast iron blocking removed, the jacks pumped up, shims replaced, and the operation repeated until all the cast iron blocking had been removed, when one of the concrete-filled cylinders was taken out, the casting and shims replaced, and so on until the span was landed on its permanent shoes. The oak blocking was also removed as the span was lowered, the top of it being kept high enough to free the jacks while shims were being adjusted.

When the span had been lowered about 4 ft. at one end, the jacks were transferred to the other and similar operations carried out there. That end, however, was lowered right down to the shoes before the jacks were returned to the end first lowered.

The bridge was designed by the bridge department of the Canadian Pacific Railway at Montreal. The substructure was built by the Toronto Construction Company of Toronto, under supervision of Mr. F. S. Darling, division engineer of construction, while the steel work was manufactured and erected by the Canadian Bridge Company of Walkerville, Ont. Mr. A. L. Colby was manager of construction and Mr. C. Prettie was general foreman in charge of the steel erection.

The writer believes that this is the longest and heaviest single track fixed span yet built and erected in Canada, or ever erected by the end launching method.



Traveler Used in Erecting French River Bridge of C. P. Ry.

The consumption of aluminum in the United States in 1907 was 17,211,000 lbs.

A Japanese-English-American syndicate is to undertake the development of several large water powers in Japan, and at a recent meeting in Tokio $6,000,000 was pledged for that purpose.

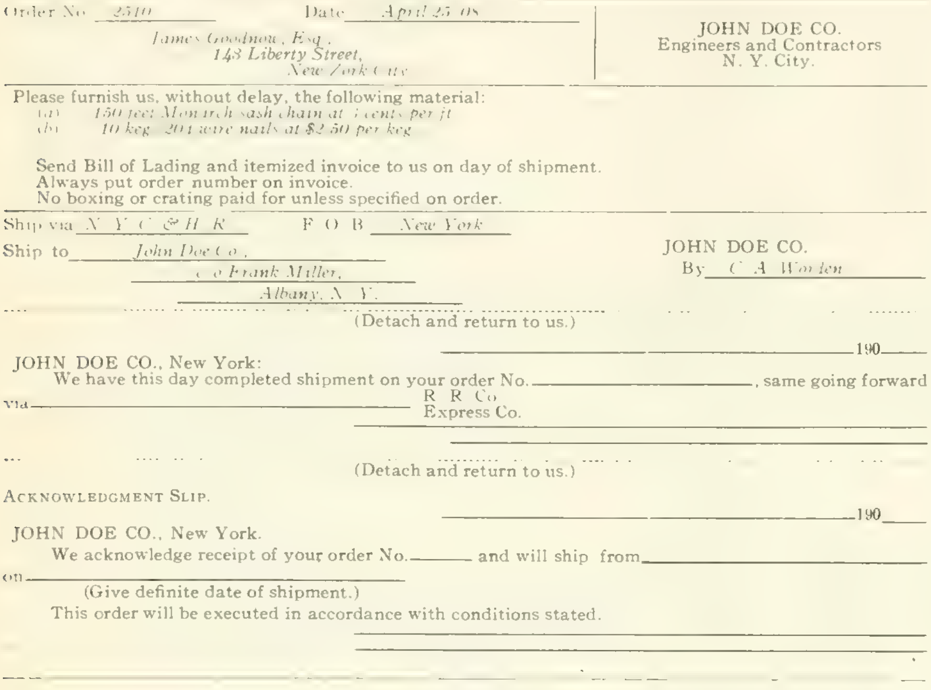
Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Card Index Order System.

BY C. ARTHUR WORDEN*

A simple, yet comprehensive order system is a great factor in contracting, a system which gives immediately all of the information required.



Order No. 2510 Date April 25 08

James Goodnow, Esq.,
143 Liberty Street,
New York City

JOHN DOE CO.
Engineers and Contractors
N. Y. City.

Please furnish us, without delay, the following material:
(a) 150 feet Monarch sash chain at 3 cents per ft
(b) 10 kegs 20d wire nails at $2.50 per keg

Send Bill of Lading and itemized invoice to us on day of shipment.
Always put order number on invoice.
No boxing or crating paid for unless specified on order.

Ship via N. Y. C. & H. R. F. O. B. New York

Ship to John Doe Co.,
c/o Frank Miller,
Albany, N. Y.

JOHN DOE CO.
By C. A. Worden

(Detach and return to us.)

190

JOHN DOE CO., New York:
We have this day completed shipment on your order No. , same going forward via R. R. Co. Express Co.

(Detach and return to us.)

ACKNOWLEDGMENT SLIP.

190

JOHN DOE CO., New York.
We acknowledge receipt of your order No. and will ship from
on
(Give definite date of shipment.)
This order will be executed in accordance with conditions stated.

Fig. 1—Order Blank.
This and the blanks shown in Figs. 2, 3, and 4 are much condensed.

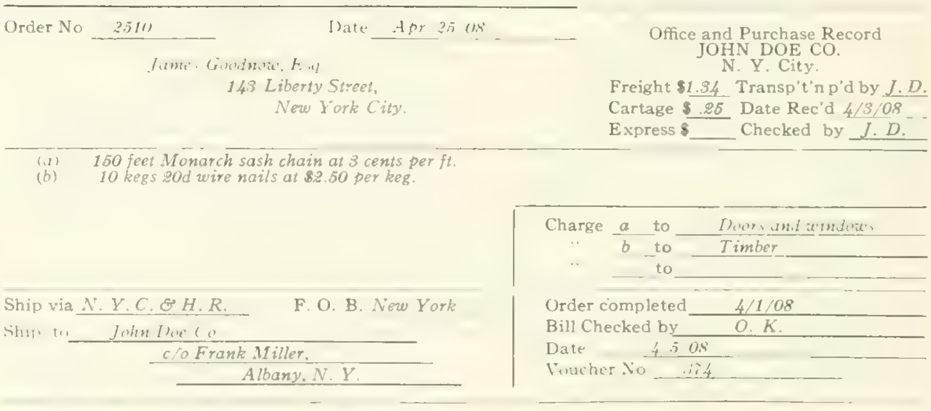
This article describes a card index system for ordering which has been used for several years by a large Eastern contracting firm, and which has proven satisfactory in every respect.

Each order is made out in triplicate. The original, Fig. 1, is mailed to the firm or party from whom the material is ordered. At times, the list of material is too large to be put on the regular order form and in that case the words "kindly furnish us with material as per list attached to and forming a part of this order" are substituted. The list is then made in triplicate, and one copy is attached to each copy of the order.

The "Office and Purchase Record," Fig. 2, is retained in the Home Office, while the "Receiving Department" copy is mailed to the Field Office having that particular contract in charge.

Fig. 1, as will be noted, gives the forwarder of material all information in regard to shipment, manner of rendering invoice, etc. Attached to this slip are two stubs: the first, or acknowledgment slip, is to be returned to the contractor immediately, stating probable date of shipment; the second slip is returned as soon as the order is completed, and should have attached, the itemized invoice and Bill of Lading.

The "Office & Purchase Record," Fig. 2, is printed on a light weight card, suitable for filing in a small vertical file. The order number, date, and name of party to whom order is given, appears in the extreme upper left hand corner, thus giving easy access to the record in the file when desired. In the upper right hand corner, blank spaces are given in which are to be noted the amount of freight, express or cartage paid by the Field Office, date of delivery, name of party paying transportation charges and party checking the material upon receipt. This information will be noted on the Record as soon as the receiving slip is received from the Field Office, and will be needed in checking the invoice. In the lower right hand corner is given the item in the cost data to which material covered by order is to be charged, date of completed shipment, name of party checking invoice, date of checking and the voucher number. The voucher is very seldom used for information, as the Office and Purchase Record will show all that is ordinarily required.



Order No 2510 Date Apr 25 08

James Goodnow, Esq
143 Liberty Street,
New York City.

Office and Purchase Record
JOHN DOE CO.
N. Y. City.
Freight $1.34 Transp't'n p'd by J. D.
Cartage $ .25 Date Rec'd 4/3/08
Express $ Checked by J. D.

(a) 150 feet Monarch sash chain at 3 cents per ft.
(b) 10 kegs 20d wire nails at $2.50 per keg.

Charge a to Doors and windows
" b to Timber
" to

Ship via N. Y. C. & H. R. F. O. B. New York
Ship to John Doe Co
c/o Frank Miller,
Albany, N. Y.

Order completed 4/1/08
Bill Checked by O. K.
Date 4 5 08
Voucher No 374

Fig. 2—Office and Purchase Record Blank.

The "cost data" to which reference is made may be described as follows:

A book is provided in which each contract is subdivided into various items, such as excavation, concrete forms, concrete, timber work, doors and windows, etc. Labor and material are charged under these headings in separate columns, so that, at any time, the cost to date of either or both may be ascertained, and at the completion of the work the contractor may see not only the total profit or loss on the job, but also how the actual cost of the various items compare with the estimated costs.

The "Receiving Department" copy, Fig. 3, is used on the job in checking material when received. In all cases the freight, express or cartage charges, if any, should appear on this slip before mailing to Home Office. This copy when received at Home Office, is attached to the Office and Purchase Record bearing same number, and filed until the invoice has been checked, when it is attached to same, thus giving a complete record of the transaction in the voucher.

The order file should be provided with three guide cards, thus:

(1) Marked "Ordered," behind which the Office and Purchase Record should be filed as soon as made out.

(2) Marked "Received." When the "Receiving Department" copy is returned, it should be attached to the Office and Purchase Record and filed behind this guide card, preparatory to checking the invoice.

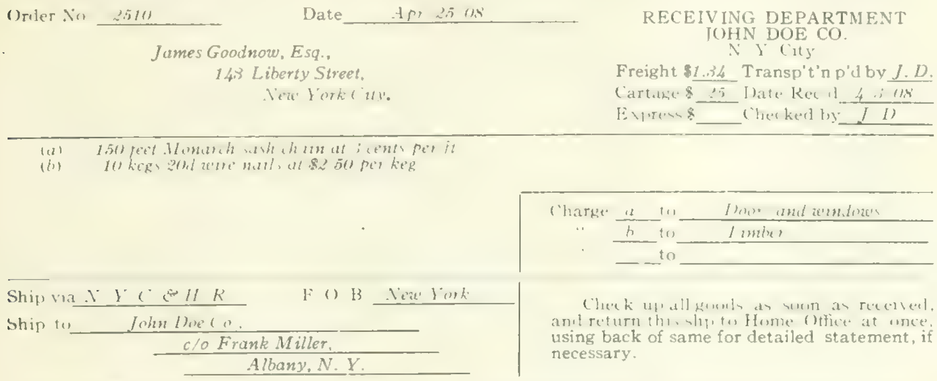
(3) Marked "Checked." This is a final file for the Office and Purchase Record as soon as invoice has been checked.

In all cases cards should be filed numerically.

Section 1 of this file can easily be converted into a follow-up file by putting in guide cards of a different color from the one marked "ordered," and numbered from 1 to 31. Order No. 2,510, say, was promised on the 29th. The Office and Purchase Record bearing this number is filed under the 29th and the order clerk in going over his records on that date will find this card and follow up the shipment.

---

*90 West St., New York



Order No *2510* Date *Apr 25 08*

RECEIVING DEPARTMENT
JOHN DOE CO.
N Y City

James Goodnow, Esq.,
143 Liberty Street,
New York City.

Freight $*1.34* Transp't'n p'd by *J. D.*
Cartage $ *.25* Date Rec'd *4 3 08*
Express $ Checked by *J D*

(a) *150 feet Monarch sash chain at 3 cents per ft*
(b) *10 kegs 20d wire nails at $2 50 per keg*

Charge *a* to *Doors and windows*
" *b* to *Lumber*
to

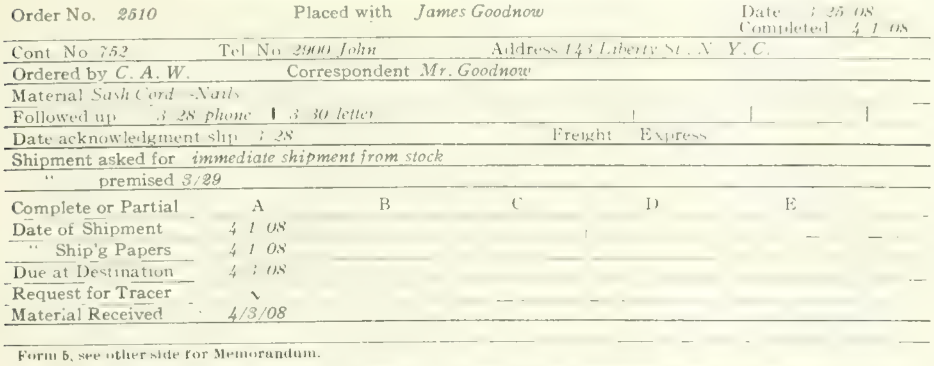
Ship via *N Y C & H R* F O B *New York*
Ship to *John Doe Co.,*
c/o Frank Miller,
Albany, N. Y.

Check up all goods as soon as received, and return this slip to Home Office at once, using back of same for detailed statement, if necessary.

Fig. 3—Receiving Department Order.

Fig. 4 shows a card system for following up, which, while more complicated, gives far more satisfactory results. This card may be filed in a "daily reminder" file under date of promised shipment, and all information can be noted thereon instead of on the Office and Purchase Record.

This card explains itself.



Order No. *2510* Placed with *James Goodnow* Date *3 25 08*
Completed *4 1 08*
Cont No *752* Tel No *2900 John* Address *143 Liberty St., N. Y. C.*
Ordered by *C. A. W.* Correspondent *Mr. Goodnow*
Material *Sash Cord -Nails*
Followed up *3 28 phone* | *3 30 letter*
Date acknowledgment slip *3 28* Freight Express
Shipment asked for *immediate shipment from stock*
" premised *3/29*

	A	B	C	D	E
Complete or Partial					
Date of Shipment	*4 1 08*				
" Ship'g Papers	*4 1 08*				
Due at Destination	*4 3 08*				
Request for Tracer					
Material Received	*4/3/08*				

Form 5, see other side for Memorandum.

Fig. 4—Card System for Follow Up.

Work is to be started in October, it is stated, on the construction of the $15,000,000 sewer system for the city of Havana.

According to the annual report of the Metropolitan Water Board for the year ending March 31, 1907, London's consumption of water was 82,125,249,347 gallons. A staff of 770 officials, receiving $753,531 in salaries, superintends the work of the board, which is shown by the following totals: Total water supplied, 82,125,,249,347 gallons; daily water supply, 225,000,683 gallons; area supplied, 537.4 square miles; population supplied, 6,851,045; daily average per person, 32.84 gallons.

LETTERS TO THE EDITORS.

Suggestions on Writing Advertisements

Sirs—I have read with interest your recent series of editorials relating to advertising, but, while I believe that most of your recommendations would be indorsed by any advertising man of extensive experience, I do not agree with you in your statements regarding the proper display of an advertisement.

I believe that the selling force put into the average trade journal advertisement is smaller than in any other class of publication and it is certain that a mail order advertiser, for example, would not continue in business a great while if he did not exhibit better salesmanship in his advertising than is shown in nine-tenths of the advertisements now appearing in the engineering journals.

There is no question but that an advertisement consisting only of the name of a machine and that of the maker is the poorest possible use of advertising space and will fetch far less returns than one containing clean cut arguments, tersely put, relative to features of the machine.

It is also true that the name of a firm or that of a machine is rarely the best headline for an advertisement, as most persons must be "baited" not only to induce them to read the first line, but the arrangement must be such as to hold attention until one's story is told

When writing an advertisement, I believe one should always consider that there are at least a half dozen classes of advertisement readers. One will only look over the illustrations, another will read the most striking captions of advertisements which "stick out" strongest, quite a number will read all of advertisements that are well written and are displayed in a manner which does not make them appear heavy, and a few will read a solid page of small type. Obviously that advertisement is best which contains the most convincing arguments and is displayed in a manner that will hold the attention of the greatest number of readers until they have read every word.

In nearly every advertisement there are two kinds of display; a type display and a white space display. This does not mean display of the caption alone, but it is carried throughout the text to not make it appear heavy. A solid page of matter, irrespective of the size of type, set in a single paragraph with lines extending the entire width of the page always appears to me heavy and difficult to read. An advertisement in which every other line is displayed in type is hard to read, but it can be displayed by making the lines and paragraphs short and using white space between the paragraphs.

In your editorial in your issue of the May 20th you discourage the use of display lines in the body of the text and say: "Display words in the body of the text, other than that in the caption at the top and the address at the bottom, distract the reader's attention from the caption. You want the words of the caption to soak into his mind deep enough to impart their meaning." Do you? If the caption is only a "catch" line, even though it leads up to the thing advertised, is it the caption you want to soak or the thing itself? I believe it is the best possible advertising to display the name of the machine in the text of an advertisement as it is important that every reader who glances over an advertisement should associate the illustration with the name of the machine.

If one were to ask the leading advertising agencies of the country to give their views on advertising display, I think I would be safe in saying that three-fourths of the replies would be in type written pages in which short paragraphs were used, single spaced in the paragraph and double spaced between the paragraphs. Nearly every advertising man knows that single spaced lines appear to be in smaller type than when double spaced, but he also knows that he can get more display in this manner and say more on a page and have it appear as though there were less type matter. Study the advertisements of the leading agencies in the literary magazines and it will be seen that they "bunch" type for the same reason.

Another point is the length of line. People are accustomed to read a line from two and one-sixth to three inches long. If a line the entire width of the page is used throughout the text, it is one to which the eye is unaccustomed and therefore difficult to read.

To illustrate the above points, take the page advertisement of The Balanced Cable Crane Co., which appeared in your issue of May 20 and to which reference was made in your editorial of that date. On account of the size of the illustration, there is a small amount of text in this advertisement and yet, in my judgment, it appears heavy and difficult to read. Had the illustration been carried up immediately following the caption and the text matter broken into short paragraphs and displayed two columns wide at the bottom of the page, set solid in the paragraphs but double leaded between the paragraphs, there could have appeared less matter on the page, it would have been easier read and, I believe, one-third more persons would read it.

Yours very truly,

F. W. Park.

[Our correspondent makes two excellent suggestions: First, that it is usually inadvisable to run a printed line clear across a page. Second, that it is usually advisable to divide the text into short paragraphs and to *separate the paragraphs by double spacing*.

Regarding the first suggestion, it should be noted that, for ease of reading, the length of the line should bear some relation to the size of the type. If the length of the line does not exceed 30 times the height of the type, it will be easily read. That ratio exists in this printed line.

Large type may, therefore, be run in one line clear across the page, but small type should be set in two or more columns.

The use of short paragraphs, well separated, certainly is commendable, and we purpose adopting this suggestion. We may add that many advertising writers, particularly in the popular magazines, use several sizes of type in all small space advertisements. The first paragraph is set in fairly large type, and each succeeding paragraph is set in smaller type.

There are two points on which we do not agree with our correspondent: First, regarding the display of the firm or product name in the text; second, regarding the placing of a cut directly beneath a caption.

We believe that it is desirable to have the caption soak into the reader's mind deep enough to impart its meaning. It is true that it is the name of the product or firm, and not the caption, which is being advertised, but it is the caption that is relied upon to lead the reader to become familiar with the product as described in the text that follows. The display of a firm name in the body of the advertising text is not the best practice, in our opinion, not only because it spoils the appearance of the text, but because it tends to make too conspicuous the fact that the advertisement is an advertisement. Moreover, the reader is not reading the text for the sake of familiarizing himself with the firm name, but for the sake of learning more about the product. Therefore, the reader is repelled rather than attracted by bold type displaying a firm name in the text. The firm (or product) name should certainly appear in the text, preferably more than once, but in type like the rest of the text.

We are aware that there are many advertising writers of experience and ability who do not agree with us on this point. The readers of this journal can be of great assistance in arriving at a conclusion, and we shall welcome letters on the subject.

Regarding the position of a cut relative to the caption of an ad, our opinion is that the cut should not be placed so as to divorce the caption from the text. In other words, the make up of an advertisement should resemble the make up of an article in this respect as well as in some other respects. The caption should be the match and the first sentence should be the kindling that starts the fire. The match ought not to be held far away from the kindling, or there will be no blaze.—Editors.]

Rock Excavation for a Pipe Sewer.

Sirs—I take the liberty of asking your advice on the following work and would appreciate very much if you would advise me either direct or through the columns of your paper.

We wish to put in 1,600 ft. of 24-in. sewer pipe in the coal mine. The entry has already been driven in the coal and the cutting would be all rock, mostly bastard limestone and sand rock. The entry is 9 ft. wide and 6 ft. high with a parallel entry running along side. We want to leave the entry in the same shape we find it in. when the job is finished.

We desire to know the best method to take this rock out, and make an estimate on the cost. Enclosed find profile of ditch and mine entry. Yours truly,

Jos. D. Wentling.

Greensburg, Pa.

[It is rather difficult to answer our correspondent with the information furnished, but it would seem advisable to lay this sewer pipe in an open trench where the cut is 10 ft. or less. A 3-ft. trench would be wide enough, even for that depth. Where the excavation would be deeper than about 10 ft. the work could probably be done with more economy by tunneling. The tunnel should be made about 3 x 4 ft. In excavating the trench it would be advisable to work in sections, and the material excavated from one section could be used to backfill over a section of pipe already laid, thus reducing the amount of rock to be carried out of the entry. Methods and costs on this character of work can be found in Gillette's "Rock Excavation—Methods and Costs."

Under any conditions, this is an expensive job, and it will necessarily be both tedious and slow to execute. With the method suggested, the entry can be left the same after the pipe is laid, as it is at present.—Editors.]

The Size of Catalogues.

Sirs: I notice in the issue of Engineering-Contracting for May 5 an article on "What Kind of Catalogues to Write." I think that the point is well taken by the writer in regard to giving full information in published catalogues regarding the material or products of the manufacturer.

Catalogues are very essential in engineer offices and especially if they are so written as to be of some service. There are many catalogues which do not amount to the cost which is paid for getting them up and sending them out, and such catalogues as a rule are thrown into the waste paper basket.

I notice one point which the writer does not mention and that is the sizes of catalogues. If there were standard sizes of catalogues, it would be much better to keep them on file. It is very seldom now that you see two catalogues of the same size, as they all vary more or less.

I have adopted for this office the standard size of letter heads, 8½x11 ins., as the standard for drawings and various books, such as permit or application books, and find the size very convenient in all cases. I would state in relation to drawings that the different sizes are made up of multiples of 8½x11. For example, most of our drawings for street maps or profiles are 22 by 42½ ins. long. If it becomes necessary to file, in connection with correspondence, or send blue prints by mail, they can be folded into the letter head size much easier.

I should like very much to make some inquiries of the writer of the article as to his method of filing such catalogues and indexing them. I have arranged a system for this office of indexing the catalogues under the name of the firm and also under different subjects. Very truly,

Henry E. Baker,
City Engineer, Watertown, N. Y.

May 22, 1908.

[The size of catalogue most commonly printed is 6x9 ins. Regarding the filing of catalogues, there is a diversity of practice, and we shall welcome suggestions from our readers.—Editors.]

Leon Delagrange, a French aeronaut, on May 30, at Rome, established a new areoplane record by flying 12,750 meters and remaining in the air for 15 minutes and 26 seconds. On the same day at Ghent, Belgium, Henry Farman, the English aeroplanist, covered 1,241 meters in his areoplane with two men on board. The feat was performed in a dead calm.

The ratepayers of the city of Toronto, Ont., will vote June 27 on a by-law to raise $2,400,000 for a trunk sewer and septic tanks.

Engineering-Contracting Monthly Review Index of Civil Engineering Literature.

A classified index and review of the civil engineering papers, articles, reports, pamphlets and books published during the month just passed is given in the succeeding pages. The literature indexed and reviewed—with the exception of books—relates solely to civil engineering. In the section devoted to Book Reviews all books in all branches of engineering are listed as received and such of them as seem worthy are reviewed as fully as due regard for conciseness will permit. In choosing books for review rigid selection is exercised. Next to careful choice of books for review, timeliness of review is sought. All books are reviewed within a month of their receipt. The same statement is true of the articles and papers that are indexed. Also, as in choosing books for review, the choice of articles and papers for indexing is based on merit. Numerical strength in "titles indexed" is not sought; excellence of selection is sought.

The purposes of the Monthly Review Index are: First, to inform civil engineers and contractors of the articles and papers of merit, that are published each month, in such a way as will give a clear idea of their character and scope; second, to supply the user with the date and place of publication, the length of each article and the cost at which it can be secured. The name, adopted abbreviation, place of publication and price per number of each periodical examined for civil engineering articles are given in the list immediately following. The other information is given in the index proper for each article separately.

Books reviewed will be sent postpaid on receipt of price by the Book Department of ENGINEERING-CONTRACTING; periodicals, etc., containing articles indexed should be ordered direct from the publishers.

LIST OF PERIODICALS INDEXED.

American Architect (Am. Arch.). New York, N. Y.; w; 7x10 in.; 15 cts.

American Builders' Review (Am. Bldrs. Rev.), San Francisco, Cal.; m; 7x10 in.; 50 cts.

American Carpenter and Builder (Am. Car. & Bldr.), Chicago, Ill.; New York, N. Y.; m; 7x10 in.; 20 cts.

American Engineer and R. R. Journal (Am. Engr. & R. R. Jl.), York, N. Y.; m; 7x10 in.; 20 cts.

American Gas Light Journal (Am. G. L. Jl.), New York, N. Y.; w; 10x13 in.; 10 cts.

American Machinist (Am. Mchst.), New York; w; 7x10 in.; 15 cts.

Annales des Ponts et Chaussees (An. P. & C.), Paris, France; m.

Architects and Builders Journal (Arch. & Bldrs. Jl.), Baltimore, Md.; m; 9x12 in.; 20 cts.

Architects and Builders Magazine (Arch. & Bldrs. Mag.), New York, N. Y.; m; 5x8 in.; 20 cts.

Architect and Engineer of California (Arch. & Engr.), San Francisco, Cal.; m; 5x7 in.; 15 cts.

Cassier's Magazine (Cas. Mag.), New York; m; 5x8 in.; 25 cts.

Bulletin International Railway Congress (Bul. Int. Ry. Cong.), Brussels; m; 50 cts.

Bulletin U. S. Geological Survey (Bul. Geo. Surv.), Washington, D. C., 4x7 in.

Bulletin U. S. Department of Agriculture (Bul. Dept. Agr.), Washington, D. C.; 4x7 in.

Bulletins Railway Engineering & Maintenance of Way Association (Bul. Am. Ry. Eng. & M. of W. Assoc.).

California Journal of Technology (Cal. Jl. of Tech.), Berkeley, Cal.; m; 4x7 in.; 25 cts.

Canadian Architect (Can. Arch.), Toronto, Ont.; m; 7x10 in.; 20 cts.

Canadian Cement and Concrete Review (Can. Cem. & Conc. Rev.), Toronto, Ont.

Canadian Engineer (Can. Engr.), Toronto, Ont.; w; 7x11 in.; 10 cts.

Canadian Machinery and Manufacturing News (Can. Mach. & Mfg. News), Toronto, Ont.; m; 7x10 in.; 15 cts.

Canadian Mining Journal (Can. Min. Jl.), Toronto, Ont.; bi-w; 7x10 in.; 20 cts.

Canadian Municipal Journal (Can. Mun. Jl.), Montreal, Que.; m; 6¾x10 in.; 10 cts.

Carpentry and Building (Carp. & Bldg.), New York, N. Y.; m; 11x8 in.; 10 cts.

Cassier's Magazine (Cas. Mag.), New York, N. Y.; m; 5x8 in.; 25 cts.

Cement, New York, N. Y.; bi-m; 5x8 in.; 25 cts.

Cement Age (Cem. Age), New York, N. Y.; m; 4x7 in.; 10 cts.

Cement and Engineering News (Cem. & Eng. News), Chicago, Ill.; 7x10 in.; 25 cts.

Cement Era (Cem. Era), Chicago, Ill.; m; 7x10 in.; 10 cts.

Cement World (Cem. Wld.), Chicago, Ill.; m; 9x11 in.; 10 cts.

Chemical Engineer (Chem. Engr.), Chicago, Ill.; m; 4x7 in.; 15 cts.

Clay Worker (Cl. Wkr.), Indianapolis, Ind.; m; 7x10 in.; 20 cts.

Compressed Air (Comp. Air), New York, N. Y.; m; 5x7 in.; 10 cts.

Concrete, Detroit, Mich.; m; 6x9 in.; 15 cts.

Concrete Age (Conc. Age), Atlanta, Ga.; m; 9x11 in.; 10 cts.

Concrete and Constructional Engineering (Conc. & Cons. Eng.), London, England; m; 5x7 in.; 25 cts.

Concrete Engineering (Conc. Eng.), Cleveland, O.; m; 7x10 in.; 10 cts.

Contractor (Contr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.

Cornell Civil Engineer (Cor. Civ. Engr.), Ithaca, N. Y.; m; 4x7 in.; 25 cts.

Dirt Mover, Columbus, O.; bi-w; 7x10 in.; 10 cts.

Domestic Engineering (Dom. Engr.), Chicago, Ill.; w; 6x9 in.; 10 cts.

Electrical Age (Elec. Age), New York, N. Y.; m; 7x10 in.; 10 cts.

Electrical Review (Elec. Rev.), New York, N. Y.; 8x10 in.; 10 cts.

Electric Railway Review (Elec. Ry. Rev.), Chicago, Ill.; w; 7x10 in.; 20 cts.

Electrical World (Elec. Wld.), New York, N. Y.; w; 7x10 in.; 10 cts.

Electric Traction Weekly (Elec. Trac. Wkly.), Cleveland, O.; w; 7x10 in.; 10 cts.

Engineer (Engr. Lon.), London, England; w; 4x11 in.

Engineer, (Engr.), Chicago, Ill.; bi-w; 7x10 in.; 20 cts.

Engineering (Eng.), London, England; w; 8x11 in.

Engineering Digest (Eng. Dig.), New York, N. Y.; m; 5x8 in.; 20 cts.

Engineering-Contracting (Eng.-Contr.), Chicago, Ill.; w; 7x10 in.; 10 cts.

Engineering and Mining Journal (Eng. & Min. Jl.), New York, N. Y.; w; 7x10 in.; 15 cts.

Engineering Magazine (Eng. Mag.), New York; m; 5x7 in.; 25 cts.

Engineering News (Eng. News), New York; w; 8x11 in.; 15 cts.

Engineering Record (Eng. Rec.), New York; w; 8x11 in.; 10 cts.

Fire and Water Engineering (F. & W. Eng.), New York, N. Y.; 8x11 in.; 10 cts.

Le Genie Civil, Paris, France; w.

Good Roads Magazine (Gd. Rds. Mag.), New York, N. Y.; m; 7x10 in.; 10 cts.

Industrial Magazine (Ind. Mag.), Cleveland, O.; m; 4x7 in.; 10 cts.

Industrial World (Ind. Wld.), Pittsburg, Pa.; w; 7x10 in.; 10 cts.

Inland Architect (In. Arch.), Chicago, Ill.; m; 7x11 in.; $1.

Insurance Engineering (Ins. Eng.), New York; m; 4x6 in.; 25 cts.

Iron Age, New York, N. Y.; w; 7x11 in.; 15 cts.

Iron Trade Review (Iron T. Rev.)..Cleveland, O.; w; 7x10 in.; 15 cts.

Irrigation Age (Irr. Age), Chicago, Ill.; m; 7x9 in.; 10 cts.

Journal Association of Engineering Societies (Jl. Assoc. Engr. Soc.), Boston, Mass.; m; 4x7 in.; 30 cts.

Journal Franklin Institute (Jl. Frank. Inst.), Philadelphia, Pa.; m; 4x7 in.; 50 cts.

Journal New England Waterworks Association (Jl. N. E. W. W. Assoc.), Boston, Mass.; q; 4x7 in.

Journal Western Society of Engineers (Jl. W. Soc. Engrs.), Chicago, Ill.; bi-m; 4x7 in.; 50 cts.

Journal of Electricity, Power and Gas (Jl. Elec., P. & G.), San Francisco, Cal.; w; 7x10 in.; 10 cts.

Journal of Worcester Polytechnic Institute (Jl. W. P. I.), m; 4x7 in.; 20 cts.

Machinery, New York, N. Y.; m; 7x11 in.; 20 cts.

Marine Review (Marine Rev.), Cleveland, O.; w; 7x10 in.; 15 cts.

Mines and Minerals (Mi. & Mls.), Scranton, Pa.; w; 7x9 in.; 20 cts.

Mining and Scientific Press. (Min. & Sci. P.), San Francisco, Cal.; w; 7x11 in.; 15 cts.

Mining Reporter (Min. Rep.), Denver, Colo.; w; 7x10 in.; 15 cts.

Mining World (Min. Wld.), Chicago, Ill.; w; 7x10 in.; 10 cts.

Modern Machinery (Mod. Mchy.), Chicago, Ill.; m; 7x10 in.; 10 cts.

Municipal Journal and Engineer (Mun. Jl. & Eng.), New York, N. Y.; w; 7x10 in.; 10 cts.

Municipal Engineering Magazine (Mun. Eng. Mag.), Indianapolis, Ind.; m; 4x7 in.; 25 cts.

Ores and Metals (O. & M.), Denver, Colo.; bi-w; 6x10 in.; 10 cts.

Pacific Building Engineer (Pac. Bldg. Engr.), Seattle, Wash.; w; 9x11 in.; 15 cts.

Popular Mechanics (Pop. Mech.), Chicago, Ill.; m; 5x7 in.; 10 cts.

The Polytechnic (Poly.), Troy, N. Y.; m; 5x8 ins., 15 cts.

Power, New York, N. Y.; m; 7x10 in.; 20 cts.

Proceedings American Institute of Electrical Engineers (Proc. Am. I. of E. E.), New York, N. Y.; m; 4x7 in.; 50 cts.

Proceedings American Society of Civil Engineers (Proc. Am. Soc. C. E.), New York, N. Y.; m; 4x7 in.; 75 cts.

Proceedings American Society of Mechanical Engineers (Proc. Am. Soc. M. E.), New York, N. Y.; m; 4x7 in.; 50 cts.

Proceedings Engineers' Club of Philadelphia (Proc. Engrs.' Club, Phila.), Philadelphia; qr.; 4x7 in.; 25 cts.

Proceedings Canadian Society of Civil Engineers (Proc. Can. Soc. C. E.), Montreal; m; 4x7 in.; 50 cts.

Railroad Gazette (R. R. Gaz.), New York; w; 8x11 in.; 15 cts.

Railway Master Mechanic (Ry. M. M.), Chicago; m; 7x10 in.; 10 cts.

Railway Age (Ry. Age), Chicago, Ill.; w; 7x10 in.; 10 cts.

Railway and Engineering Review (Ry. & Eng. Rev.), Chicago, Ill.; w; 9x11 in.; 10 cts.

Railway and Locomotive Engineering (Ry. & Loco. Eng.), New York, N. Y.; m; 7x10 in.; 20 cts.

Railway and Marine World (Ry. & M. Wld.), Toronto, Ont.; m; 7x10 in.; 15 cts.

Railway Engineering and Maintenance of Way (Ry. Eng. & M. W.), Chicago, Ill.; m; 7x10 in.; 10 cts.

Roadmaster and Foreman (Rd. & For.), Chicago; 7x-0 in.; 10 cts.

Rock Products (Rk. Prod.), Chicago, Ill.; bi-w.; 9x11 in.; 10 cts.

Rose Technic, Terre Haute, Ind.; m; 4x7 in.; 15 cts.

School of Mines Quarterly (Sch. Min. Quart.), New York, N. Y.; qr.; 4x7 in.; 30 cts.

Schweizerische Bauzeitung, Zurich; w.

Scientific American (Sci. Am.), New York; w; 9x14 in.; 10 cts.

Scientific American Supplement (Sci. Am. Sup.), New York, N. Y.; w; 9x14 in.; 10 cts.

Sibley Journal of Engineering (Sib. Jl. Eng.), Ithaca, N. Y.; m; 4x7 in.; 20 cts.

Stevens Institute Indicator (Stev. Inst. Ind.), Hoboken, N. J.; m; 4x7 in.; 20 cts.

Street Railway Bulletin (St. Ry. Bul.), Boston; m; 6x10 in.; 10 cts.

Street Railway Journal (St. Ry. Jl.), New York, N. Y.; w; 7x10 in.; 10 cts.

Technology Quarterly (Tech. Qr.), Boston; qr; 4x6 in.; 35 cts.

The Surveyor (Surveyor), London, England; w; 6x11 in.; 10 cts.

Waterproofing (W. P.), New York, N. Y.; m; 5x8 in.; 10 cts. .

Zeitschrift d. Oest. Ing. u Arch. Ver. Vienna; w.

Zeitschrift d. Ver Deutscher Ing.; Berlin; w.

ROADS AND STREETS.

Tamped Oiled Roads.—Chas. A. Byers, Ind Mag., May, 1908, 6 pp.

An article describing the successful use of and construction of Petrolithic Roads in California. Also tells of the methods of building such roads and pavement and illustrates the roller used. States that neither heat nor cold, no matter how severe, will affect such roads, and the methods used can be adopted by road builders in any part of the world. The finished road is hard, smooth, dustless, proof against water and it is not subject to abrasion.

City Refuse and Street Cleaning. Mun. Jl & Engr., May 13, 1908; 5 pp.

Abstract of a report by a special commission appointed to investigate the refuse and street cleaning problem of New York City. Data as to the weight of city refuse, and street sweepings are given, and estimates are given of the cost of street cleaning by machine sweeping, hand sweeping and street flushing.

Some Data on the Cost of Street Sweeping Taken from a Recent Report, Together with Other Data Secured by Engineering-Contracting. Eng.-Contr., May 6, 1908; 1⅓ pp.

Data on the cost of street cleaning by hand and machine are given in this article.

Cost Data on Experimental Oiling of New York State Highways, Together with the Results Obtained. Eng.-Contr., May 6, 1908; 2 pp.

The article contains data on the oiling of macadam, gravel and sand roads. The condition of the treated roads after they had been subjected to fall traffic and the influence of winter conditions is also described.

The Evolution of Pavements. By G. L. Claussen Mun. Eng. Mag June, 1908, 1½ pp.

An article giving a short resume of the writer's experience and observation in 28 years of street pavement work.

Iron Slag or Scoria Paving Blocks. By H. C. Innes. Mun. Eng. Mag., June, 1908; 1 p.

Describes the slag or scoria brick or block used for paving material.

The Municipal Asphalt Repair Plant of the Borough of Brooklyn, and Data on the Cost of Operating It. Eng.-Contr., May 27, 1908; 2 pp.

Short descriptions of the municipal asphalt repair plant of Brooklyn, N. Y., together with data on the cost of operating it, from the time it was placed in operation on June 13, 1907, to Dec 31, 1907.

United States Government Experiments with Dust Preventives. Good Roads Mag., May, 1908, 2 pp.

An abstract from a report of the U. S. Office of Public Roads. The article treats of 13 experiments with tar mixtures, and gives data on the cost of the work.

The Gladwell Method of Treating Macadam. Good Roads Mag., May, 1908; 3 pp.

Describes the methods employed by the English Road Engineer, Arthur Gladwell, of preserving the surface of macadam roads from the effects of motor traffic. The article is taken from a joint description by Mr. Gladwell and George W. Manning, engineers, respectively to the Eton and Staines Rural District Councils in England.

Present-Day Road Requirements in Town and Country. By A. Brown. Good Roads Mag., May, 1908; 3½ pp.

An abstract of a paper read before the Royal Sanitary Institute of Great Britain. The article in a general way describes the various kinds of paving to be found on main streets of English cities and towns, and gives some cost figures. Reference is also made to dust prevention and some of the palliatives used are described.

Specifications for Mariposa Oil Macadam Road, Stockton, Cal. Specifications prepared by N. Ellery, State Highway Commissioner of California, for the construction of an oiled macadam pavement.

SEWERS.

Sewage Pumping Station and Submerged Force Main, Salem, Mass. By W. F. Bates, Eng. News, May 28, 1908; 2 pp.

Describes centrifugal sewage pumping plant of 19,000,000 gals. capacity against 60 ft. head per 24 hours and force main 9,950 ft. long from plant to outlet under water. Comparisons of cost are given between electric and steam operation of pumps, and the method of constructing the submerged outlet is described.

Cost of Brick, Concrete and Pipe Sewers. Eng News, May 21, 1908; ½ p.

Gives in tabular form cost of constructing 36 to 72 in. sewers of brick and of reinforced concrete at Wilmington, Del.; also cost of 8 to 24-in. pipe sewers. The figures are valuable.

Novel Piece of Outfall Sewer Construction, Chicago, Ill. Eng. Contr., May 6, 1908; 1 p.

Gives structural details and describes construction of permanent masonry and temporary wooden sewer outfall, showing method of handling sewage flow during construction.

Ohio Law Governing Water and Sewage Purification and Stream Pollution. Eng.-Contr., May 6, 1908; 1 1-3 pp.

Gives full text of law empowering Ohio State Board of Health to require construction of water and sewage purification plants and to exercise supervisory control over such plants after construction.

The Design of a Sewer. By Frank R. Durham. The Surveyor, May 22, 1908; 9 pp.

The article deals with the salient features of the design and construction of a sewer system. Numerous drawings are included in the article.

Strength of Cement and Clay Pipe. By Prof A. Marston. Mun. Jl. & Engr., May 27, 1908; 2 pp.

A paper read before the Iowa Association of Cement Users giving results of tests made at the Engineering Experiment Station at Iowa State College. Tests were made showing the comparative strength of cement and clay drain tile of various diameters and thicknesses.

WATER-WORKS AND HYDRAULICS.

Port Falls Development, Washington Water Power Co., I. By C. S. MacCalla, Elec. W'ld., May 23, 1908; 3½ pp.

Describes in general way, with illustrations, the controlling works, dam and power house work of this new hydro-electric power development. The dam was of concrete and was made waterproof by applying Sylvester wash to the upstream face.

Development of a Water Supply from a Gravel Bed. By Edwin Duryea, Cor. Civ. Engr., May, 1908; 5 pp.

General description of methods adopted in sinking a caisson 80 ft. to a gravel bed, driving two short tunnels laterally from bottom of shaft and connecting tunnels with wells by tubing.

Corrosion of the Steel Water Supply Conduit at Rochester, N. Y. By R. H. Gaines, Eng. News, May 28, 1908; 7 pp.

Report of a careful investigation of the amount of corrosion and its causes in the steel pipe line of the Rochester, N. Y., water supply. The conclusion is that the corrosion was caused by electrolysis, the current for which resulted from chemical processes between water solutions in the soil and the metal. The paper is of decided interest to waterworks and hydraulic engineers.

Operations of the Water Softening Plant at Oberlin, Ohio. Eng. News, May 7, 1908; 2-3 p.

Extracts from report of W. B. Gerrish Engineer, Oberlin Water Works, describing results obtained and the means used. The

JUST PUBLISHED

The Design of Typical Steel Railway Bridges

An Elementary Course for Engineering Students and Draftsmen

By W. CHASE THOMSON, M. Can. Soc. C. E.

Assistant Engineer, Dominion Bridge Co., Ltd., Montreal

Author of "Bridge and Structural Design"

Cloth; 6x9 inches; vii + 178 pages; 21 diagrams and detail drawings (including 5 folding plates).

Price, $2 00 net

This work is a sequel to "Bridge and Structural Design," by Mr. Thomson, and, like it, has been developed from a series of lectures given by him under the auspices of the Dominion Bridge Company. The structures chosen for treatment represent the types of railway bridges most generally in use, and have been selected because they are best suited to illustrate the problems which present themselves most frequently to the bridge designer. They include the following: a 60-ft. Deck Plate Girder, a 100-ft. Deck Warren Girder, a 150-ft. Through Pratt Truss, a 200-ft. Through Pratt Truss with curved top chord, a 170-ft. Swing Bridge, and a Railway Viaduct.

The work opens with a general specification for governing the loads, unit stresses, and such other details as require the attention of designers. This is followed by tables setting forth the unit stresses permissible in columns and the rivet values used in the designs. Instructions are then given for constructing the moment diagram which is employed in computing the bending moments and shears for wheel loads. This has been found to be the most satisfactory method of dealing with wheel loads, as it affords a rapid and reliable solution, and significant errors are less likely to occur with its use than with that of any form of moment table.

The designs of the different structures are then considered in detail. Commencing with the main dimensions of the structure to be designed, and stating the loads which it has to carry, the stresses in its various members are first determined. The dimensions of these members are then computed and the details carefully worked out. The numerical calculations are given in full for each design, together with an estimate of the weight of the completed structure. This last feature is an important one, as estimating forms a large part of the work of the designer.

Some of the more important variations from the types of bridges considered are also dealt with briefly in Chapter VIII., in order to show how the principles previously set forth and illustrated may be applied to them. In the chapter devoted to the design of a 170-ft. swing bridge, the calculations for the lifting and turning machinery are given in full. The closing chapter is given up to the explanation of a simple and logical method of proportioning the lattice bars of compression members, together with its application, to a number of specific instances.

The author, an experienced engineer actively engaged in bridge design, has produced a book of manifest practical value for the instruction of civil engineering students, and one which can be studied with profit by those in actual practice, as well as by draftsmen who desire to become familiar with the methods employed in designing offices.

The Engineering News Book Dept.

220 Broadway, NEW YORK

cost per 1,000 gallons of water treated is given as 1.3 cts.

Method and Costs of Cleaning Driven Wells at Lowell, Mass. By R. J Thomas, Eng. News, May 7, 1908; ½ p.

The wells, 2½ ins. in diameter and from 30 to 40 ft. deep, are cleaned by forcing down a brush to loosen deposit and then flushing and pumping by hand A gang of 12 men is required. The cost of cleaning 345 wells twice a year is given as $1,313, or about $1.90 per well per cleaning.

Outline of the New Water Supplies for Oakland, Cal., and Other Cities on the East Shore of San Francisco Bay. By P. E. Harroun. Eng. News, May 7, 1908, 1½ pp.

The large influx of population following the San Francisco fire increased enormously the consumption of water in Oakland and neighboring cities and this article outlines the plans made for both temporary and permanent additions to meet this demand. The permanent plans call for an earth dam 124 ft. high and a masonry dam 192½ ft. high among other structures.

Brooklyn's High Pressure Service. Mun. Jl. & Engr., May 6, 1908; 2½ pp.

General article describing the high pressure service of Brooklyn, N. Y. Describes the two pumping stations, which are equipped with electric driven multi-stage turbine pumps.

Water Works Statistical Tables. Mun. Jl. & Engr., May 6, 1908; 9 pp.

These tables were compiled from data obtained from the superintendents of about 400 plants in various parts of the United States. Two series of tables are given—pumping statistics and water works data. The table of pumping statistics contains information from various cities as to the makes of pumping machinery employed, kind of fuel used, average price of fuel, per cent of ash, coal consumed during 1907, total pumpage, average head pumped against duty, and cost of pumpage per 1,000,000 gallons. In the table of water works data, information from various cities is given as to the source of supply, the method of obtaining it, the average consumption, the kinds and sizes of pipe used, total length of distribution system, cost of repairs per mile in 1907, number of leaks in 1907, number of hydrants in use, and number of gates in use. Information as to service connections, such as numbers, sizes, average length, average cost, etc., is given.

A Wood Pipe Conduit. By T. Chalkley Hatton. Mun. Jl. & Engr., May 6, 1908.

The construction of a 24-in. sectional-made stave pipe line is described in this article. The pipe line was constructed at Carney's Point, N. J., and was about four miles long. A description and drawings of an automatic regulating valve built into the conduit are given.

Estimated Life and Depreciation of Waterworks Plants. Mun. Jl. & Engr., May 6, 1908; 1 p.

A table compiled by Wm. H. Bryan from various sources showing the estimated life and depreciation of water works plants. The table contains estimates of the life and depreciation of the complete works, boilers, buildings, pumping engines, pipes, etc.

New Orleans Waterworks. Mun. Jl. & Engr., May 6, 1908; 6½ pp.

General article describing the new water works of New Orleans. Numerous illustrations, including a general plan of the purification plant are given.

Prices Paid for Cast Iron Pipe, by St. Louis, Mo., During 20 Years. Mun. Jl. & Engr., May 6, 1908; ½ p.

A table showing the prices per ton paid by the city of St. Louis, Mo., for various sizes of cast iron pipe from 1888 to 1907.

The Louisville Water Tower. Mun. Jl. & Engr., May 6, 1908; 1½ pp.

General article describing the tower and tank of the Louisville Water Co. The tank has a diameter of 50 ft., is about 90 ft. high, and is supported by a steel tower of eight columns. It is said to be the largest water tower ever constructed.

Small Water Supplies. By W. H. Booth. The Surveyor, May 15, 1908, 1 pp.

A paper read at the recent convention of the Municipal, Building and Public Health Exhibition (London). It treats of the water supply systems of small towns

The Bacteriological and Microscopical Examination of Water. By W. J. Dibbin. The Surveyor, May 15, 1908, 1 p.

Abstract of a paper read at the recent convention of the Municipal, Building and Public Health Exhibition (England).

Curve Resistance in Water Pipes. By Ernest W Schoder Proc Am Soc C E., May, 1908; 20 pp.

Gives an account of experiments made at Cornell to test the losses of head due to each of a number of 90-degree curves of different radii, for various ranges of velocities. The results are shown in tabular forms and with diagrams. It is stated that precise laws cannot be stated until further experimenting is done

Character and Composition of Incrustation in Discharge Pipe at Quincy, Ill. By Prof. Edward Bartow Mun. Eng Mag., June, 1908; 2 pp.

Contains a chemical analysis of specimens of the incrustation of the delivery pipe at the Quincy, Ill., water works.

Stripping Reservoir Lands. By J. M. Diven. Mun. Eng. Mag., June, 1908, 3 pp.

A paper read before the convention of the American Waterworks Association. It gives the writer's experience in work done at Elmira, N. Y., and Charleston, S. C.

Incrustation of Water Pipe. By W. R. Gelson. Mun. Eng. Mag., June, 1908; 2 pp.

Describes incrustation experiences at Quincy, Ill., the experiences emphasizing the fact that solutions of iron and lime should not be together forced through long lines of pipe.

A Large Waterworks Siphon. By Howard A Dill Mun. Eng. Mag., June, 1908, 2 pp.

A paper read at the convention of the American Waterworks Association, describing the 16-in. siphon line, three miles in length, at Richmond, Ind.

IRRIGATION AND DRAINAGE.

Development of Agricultural Drainage in Illinois and Iowa—Controlling Laws, Physical Conditions and Costs. By Jacob A. Harman Eng.-Contr., May 13, 1908; 3⅔ pp.

This paper gives a general review of the drainage laws of Illinois and Iowa with a description of the method of procedure under these laws in developing drainage districts which should be useful to drainage engineers. The geographical and topographical conditions of drainage work in the two states named are described, and the effect of drainage on high water, the necessity of drainage surveys, the recurrence of wet and dry years, depth of ditches, etc., are discussed. General figures of cost of drainage are given.

RIVERS, HARBORS AND CANALS.

Relation of Water Conservation to Flood Prevention and Navigation in the Ohio River. By M. O. Leighton, Eng. News, May 7, 1908; 7 pp.

This paper is an extended argument for flood prevention and the improvement of navigation on the Ohio River by means of storage reservoirs. Incidentally this method of regulation is urged for rivers generally. The author's contentions are as follows:

(1) That the logical way to control a

IN PRESS

The Design
Of Highway Bridges
and the
Calculation of Stresses in
Bridge Trusses

By MILO S. KETCHUM, C. E., M. Am. Soc. C. E.
Dean of College of Engineering, and Professor of Civil Engineering, University of Colorado
Author of "Steel Mill Buildings" and "Walls, Bins and Grain Elevators"

Cloth; 6x9 inches; 300 figures in the text, 50 tables, and 8 folding plates. Printed and bound uniform with "Steel Mill Buildings" and "Walls and Bins"

TABLE OF CONTENTS

Part I. Stresses in Truss Bridges
Chapter I Types of Truss Bridges
" II. Loads and Weights of Bridges.
" III Methods for the Calculation of Stresses in Framed Structures.
" IV. Stresses in Beams.
" V Stresses in Highway Bridge Trusses.
" VI. Stresses in Railway Bridge Trusses.
" VII. Stresses in Portals and Lateral Systems.
" VIII. Stresses in Pins, Combined and Eccentric Stresses, Stresses in Rollers, Deflection of Trusses, Camber, etc.
" IX The Solutions of 24 Problems in the Calculation of Stresses in Bridge Trusses.

Part II. The Design of Highway Bridges
Chapter X The Design of Short Span Steel Bridges.
" XI The Design of High Truss Steel Bridges.
" XII. The Design of Plate Girder Bridges.
" XIII. The Design of Truss Members.
" XIV. The Details of Highway Bridge Members.
" XV The Design of Abutments and Piers.
" XVI. Stresses in Masonry Arches.
" XVII. Design of Masonry Bridges and Culverts.
" XVIII. The Design of Timber and Combination Bridges.
" XIX. The Erection of Highway Bridges.
" XX. Estimates and Cost of Highway Bridges.

Part III. Highway Bridge Details
Chapter XXI Estimate of the Weight of a 160 foot span Steel Pin Connected Highway Bridge
" XXII. Calculation of the Efficiencies of the Members of a 160 foot Span Steel Pin Connected Highway Bridge.
Appendix I. General Specifications for Steel Highway Bridges

WRITE FOR FURTHER INFORMATION

The Engineering News Book Dept.
220 Broadway, NEW YORK

[illegible] to control the sources of its water supply;

(2) That in nearly all of the rivers of the United States such control can readily be effected by the construction of storage reservoirs;

(3) That the way to prevent floods is to use these reservoirs to catch and temporarily hold the flood waters, so that they will not descend upon the lower valleys in so large unit volume;

(4) That in the majority of cases the improper and illogical way to attempt the control of floods is to endeavor to confine the rivers between high and expensive levees;

(5) That except along those portions of rivers between high and expensive levees.

(5) That except along those portions of river channels that are too steep for open navigation, the proper way to maintain navigable depth at the low-water season is to provide, if possible, for the intelligent release of stored water.

(6) That canalization of rivers should be the resort only along those portions of the channel too steep for open navigation or in the tributary basins of which sufficient flood water cannot be stored to maintain navigable depth at low water; further, that when such results may be derived from storage reservoirs, canalization is disproportionately expensive in maintenance and the money so expended might be used for more useful purposes in the uplands.

(7) That while the first cost of the proposed conservation system will be large, the burden will be widely distributed over a series of years necessary to complete the construction.

(8) That the ultimate cost will appear nominal when compared with the enormous benefits conferred, these benefits being applied to water power and to irrigation, as well as to flood prevention and navigation.

Method and Cost of Lock and Dam Construction by the U. S. Government on the Upper White River, Arkansas. Eng.-Contr., May 6, 1908; 12 pp.

This is a remarkably complete cost account of a large government engineering work. The work comprised the construction of a concrete lock and dams, abutments, bank revetment and miscellaneous structures. The methods of construction are described and the costs for every part of the work are separately itemized and reduced to units. The expenditure involved amounted to $262,628.

Notes upon Docks and Harbors. By Luther Wagoner. Proc. Am. Soc. C. E., May, 1908; 13 pp.

A paper written from data procured by the author in visiting the principal ports of Europe and the United States. He compares European and American harbors, gives a chart showing the progress of banking, commerce, shipping, population, etc., in the world so as to arrive at some basis for the growth of San Francisco, Cal., along these lines. Discusses the use of concrete and timber for docks and wharves, the use of cranes on wharves for handling freight, and other details.

RAILWAYS.

Itemized Cost of Great Northern Railway System as Estimated by its Chief Engineer. Eng.-Contr., May 6, 1908; 3 2-3 pp.

Gives estimated cost of reproducing the Great Northern Railway System new at present prices as figured by Chief Engineer A. H. Hogeland and presented in testimony in the Spokane Rate Case. In addition to the itemized summaries, the article gives in detail the figuring adopted in arriving at the unit prices adopted.

Mountain Railroad Location. R. R. Gaz., May 15, 1908; 3½ pp.

From a paper by J. [illegible] [illegible] be-

"I would have given $1,000.00 for this book a year ago."—W. H. Burk, Knoxville, Tenn.

"FIELD SYSTEM"

By FRANK B. GILBRETH, M. Am. Soc. M. E.

WHO THE AUTHOR IS.—Frank B. Gilbreth is the contractor who has made the "cost-plus-a-fixed-sum-contract" famous. In order to handle contract work scattered all over North America, Mr. Gilbreth found it necessary to develop a system whereby his foremen would execute work properly, promptly and economically. The code of rules and instructions to his foremen, and the printed forms for their reports, were bound in book form, and this book Mr. Gilbreth called his "Field System." Mr. Gilbreth's contracts have covered the widest possible range. Railways, canals, dams, factories, office buildings, whole industrial towns, are among the works that he has executed.

WHY ENGINEERS SHOULD STUDY "FIELD SYSTEM."—Every engineer should know how to manage men, for, whether he confines himself to purely professional work or enters into business of executing construction work, his ambition should be to direct the men under him in a manner that will secure the greatest possible efficiency. A revolution in the art of managing men is now in progress. Direct personal supervision was once deemed essential. To-day, however, "system" is fast supplanting personal supervision. By "system" we mean printed or written directions for employes to follow, and daily reports that show what the employes have done. System of this sort has recently been extended to the field survey work of the U. S. Geological Survey. While Gilbreth's "Field System" is not a system for the management of surveys, for example, it is rich in suggestions that can be applied in the management of any kind of field work, whether employes are engaged in surveying or in construction. Its rules and methods are applicable to office work, in so far as the principles involved are concerned. The book, in brief, is a treatise on the science of managing men by system. No engineer who aims to be more than a subordinate can afford not to have this treatise, written by a man who is an acknowledged adept in managing men.

Hundreds of engineers have gone into the contracting business during the past few years, and there is room for thousands more. But if they are to succeed in any great measure, it must be by the intelligent application of system and cost analysis. Gilbreth's "Field System" does not cover the whole field, nor was it written to cover it, but it does cover a very important part of the field, and a part upon which practically nothing has ever been written.

WHY CONTRACTORS SHOULD HAVE "FIELD SYSTEM."—Mr. Gilbreth has done in contracting what Mr. W. L. Douglas and Mr. Marshall Field have done in the mercantile field. He has taken a class of work involving endless detail, and has reduced the handling of these details to a system by virtue of which economy in construction and celerity in performance are secured, regardless of place or men. Every one has heard the expression, "one-shovel contractor," meaning a contractor capable of managing only one steam shovel at a time. The "one-shovel contractor" is the antithesis of the contractor having a system. The "one-shovel contractor" receives daily reports, it is true, but his reporters are his two eyes. The "one-shovel contractor" has a code of instructions for his men, it is true, but his ready tongue is the only leaf of a code bound between the cover of two jaws. The day of the "one-shovel contractor" is not yet gone entirely, but it will pass rapidly away. Every contractor should have a field system of his own, embodying his own experiences and covering his own necessities, but in the developing of such a field system no contractor can afford not to study the work of Mr. Gilbreth.

COPIES OF "FIELD SYSTEM" STOLEN.—When it became generally known that Mr. Gilbreth had supplied his foreman and superintendents with printed instructions, copies of the book were bribed from his employes, and photographed page by page, from cover to cover. Other copies were "lost," and thus made way with entirely. Huge salaries were used to hire away Mr. Gilbreth's superintendents, for the purpose of getting not only their trained services, but for their knowledge of the contents of the "Field System."

MAKING THE BOOK PUBLIC.—Mr. Gilbreth's action in making public his "Field System" in its entirety is without precedent in the world of business. It is an act that puts contracting on the high professional level of civil engineering. The civil engineer discloses his method of designing a structure, his purpose being to assist other engineers in doing as well. In the interest of scientific advancement the engineer places on record what he has found to be economic or effective. In the same spirit—we may call it the modern American spirit—Mr. Gilbreth has permitted publication of his private code of instructions to his men—his "Field System." He believes that contractors, and, indeed, all professional business men, will become far more efficient as managers of men if such systems as this are disclosed. He believes that in the general rise of efficiency that will occur all those engaged in business will share. He believes that those who are best fitted to be leaders will remain leaders. Character, experience and ability will have the same relative weight as ever. In these beliefs every broad-minded man ought to concur.

China is a nation that worships "trade secrets." It is a nation of industrial mutes. Their arts and their manufactures are taught by father to son, and zealously guarded. There has been no pyramiding of improvements upon one original invention as a base. The Chinese do not lack inventive ability. They are merely cursed by the curse of secretiveness. Their industries are plastered with signs of "No admittance," and are mummified in consequence. In striking contrast with the Chinese method is the American method. Our doctors, or engineers and our men of science generally have never concealed their discoveries or their improvements. Latterly our business men have shown a recognition of the truth of the general proposition that it pays the individual to share his discoveries with the rest of his fellows. Such generosity, in the final analysis, is simply an enlightened selfishness. The publishers of Gilbreth's "Field System" urgently request other contractors and business men to come forward with their systems, and put them permanently on record. Let business men generally adopt the altruistic policy that actuates professional men, and in its prosperity America will soon rise as far above its present level as it now stands above the level of the Chinese Empire.

PRICE OF THE "FIELD SYSTEM."—The book has 200 pages, bound in leather, and its price is $3 net, postpaid. Order now, before the edition is exhausted.

THE MYRON C. CLARK PUBLISHING CO.

355 Dearborn Street, Chicago

fore the Pacific Northwest Society of Engineers. The subject is treated in a very practical manner from the selection of the party and outfit to the actual field work. Some excellent suggestions are made in the paper, ending with some figures on cost of making surveys.

Management of the Black Locust Plantations of the Pennsylvania R. R. By E. A. Sterling, Eng. News, May 14, 1908; ¾ p.

Plantations of locust trees to supply railway timber for the Pennsylvania R. R. were began in 1902 and now cover some 2,000 acres. The article describes briefly the arrangement of these plantations and gives more at length some of the lessons learned as to the best methods of managing them

New Rail Sections and Rail Specifications of the American Railway Association. Eng News, May 14, 1908, 3 2-3 pp

During the last year a committee of the American Railway Association has worked out complete specifications for Bessemer steel and open hearth steel rails and has designed two series of new rail sections. This article illustrates the new rail sections and gives the specifications in full.

Cost of Narrow Gage Railways in Africa.—Eng. News, May 21, 1908; 1-3 p.

Gives gage and cost of several African railways, including the Natal Government Railways, per mile of line. The figures are of general interest only.

Heating of Passenger Trains. By Geo. E. Smart. Proc. Can. Railway Club; 9 pp.

A paper read before this club on the various systems and methods of heating cars. A very practical paper. In the paper and discussion many hints on steam heating and the care of the heating apparatus are given.

ELECTRIC RAILWAYS AND POWER.

T-Rail Track Construction. By Mark Lowd, Elec. Ry. Rev., May 16, 1908; 1½ pp.

Discusses the advantages of T-rail over girder rails for street railway track construction and gives suggestions for roadbed and track construction and paving. A good general article.

System and Operating Practice of the Commonwealth Edison Co., Chicago. Elec. W'l'd. May 16, 1908; 21 pp.

This is a general description, with line maps, powerhouse plans, etc., of the entire generating and distribution system of the electric company that furnishes practically all the electricity for industrial lighting and power in Chicago. As a general description of a great plant the article will interest engineers.

Underground Conduit System at Davenport, Ia. By A. J. Quigley, Elec. W'l'd., May 23, 1908; 2 1-3 pp.

Describes structural features of manholes and conduits and gives general figures of cost of constructing some 250,000 duct feet of 4 to 12-duct conduits.

Way Department of the Public Service Railway Co. By M. Schreiber, St. Ry. Jl., May 2, 1908; 9¾ pp

The electric railway system considered in this article has some 675 miles of track. The article describes the organization of the maintenance of way department and in general the methods pursued in construction and maintenance work. Special descriptions are given of work cars, traveling concrete mixers, stone crushing plant, and of the standard track constructions.

Maintenance Shop Costs and Painting Practice, Interborough Rapid Transit Co. St. Ry. Jl., May 23, 1908; 3¼ pp.

Gives itemized costs of winding armatures,, renewing wheels and painting wooden cars at the shops of the company named with a general description of the methods of work followed.

TUNNELS AND SUBWAYS.

Rapid Transit. By W. Barclay Parsons. Ind. Mag., May; 17 pp.

A paper read at Purdue University. Deals with the subject of rapid transit in a general way and from the broad engineering principals. The major part of the article is devoted to rapid transit by subways, giving lessons learned both in Europe and America.

The Thames Tunnel. R. R. Gaz., May 22, 1908; 3 pp.

A report from a pamphlet published in 1840 describing the method of building a double tube tunnel under the River Thames in London. A shield was used in this work. Cuts are given showing the shield and other details of the work.

BRIDGES AND BUILDINGS.

Methods of Erecting a Steel Arch Bridge. Eng.-Contr., May 6, 1908, 2 2-3 pp

Abstract of a paper read before the American Society of Civil Engineers by L. D. Rights describing in detail method of erecting 540-ft. steel arch highway bridge at Billow's Falls, Vt. Drawings of falseworks and erection plant lay-out are given and experience of operations is described.

Waterproofing Bridge Floors. Ry. Age, May 15, 1908; 3 pp.

Suggestions are made as to the waterproofing of concrete and steel railway bridges. Various methods in use are described. It is also pointed out that the bridge design is seldom considered from the standpoint of the best and cheapest way to waterproof the floor.

Notes on the Footbridge, Lock and Weir, Richmond (Surrey, England). By J. H. Brierly. The Surveyor, May 15, 1908; 4½ pp.

General description with drawings. The structure consists of a bridge having five arches, and carrying a double gangway, 348 ft. in length, between the banks, and 28 ft. in width. The two gangways are each 6 ft. wide, with a central space of 16 ft. between them, which is occupied by the sluices when raised.

CONCRETE AND REINFORCED CONCRETE.

Reinforced Concrete Band Stand. By W. F. Creighton, Eng. News, May 28, 1908; 1¼ pp.

Describes construction of mushroom-shaped band stand 32 ft. in diameter, showing reinforcement and giving itemized cost of construction.

Concrete Houses. Cem. Age, May, 1908; 54 pp.

A series of articles illustrating and describing concrete houses constructed in various parts of the country together with a series of eleven designs for concrete houses with itemized estimates of cost. An interesting series of articles to architects and builders.

Concrete Dam of the Lynchberg Water Supply. Eng. Rec., May 16, 1908; 1 p.

This dam for the 500,000,000-gal. reservoir for water supply was built of concrete blocks. The height of the dam above the rock is 70 ft. The dam and pipe connections with it are described in the article.

Sinking a Concrete Lined Mine Shaft. Eng. Rec., May 16, 1908; 1 p.

Describes the use of concrete for lining a mine shaft. A steel cutting shoe was laid down and a concrete wall built upon it, then the excavation was started and the weight caused the walls to sink. As the concrete casing sunk the walls were extended with the same forms adding more weight. It was taken to a total depth of 100 ft.

Reinforced Concrete Overgrade Highway Crossings. R R Gaz., May 22, 1908; 2 pp

Cements, Mortars and Concretes
—Their Physical Properties
An up-to-date Compendium of Reliable Tests of Cements, Mortars and Concretes
By
MYRON S. FALK, Ph. D.
Instructor in Civil Engineering, Columbia University.

This book contains a very complete report of the results of tests made during the past fifteen years, and gives these results in tables and diagrams classified according to subjects. This is a reference book that should be in the library of every civil engineer. The contents include chapters on Chemical Properties of Cement, Physical Tests of Cement, General Physical Properties, Elastic Properties in General, Tensile Properties, Compressive Properties, Flexural Properties, Report on Uniform Tests of Cement by the Special Committee of the American Society of Civil Engineers, and Constitution of Cement.

Cloth, 6x9 inches; 184 pages; illustrated; price $2.50 net, postpaid.

Practical Cement Testing
By
W. PURVES TAYLOR, M. S. C. E.
Engineer in Charge of Philadelphia Municipal Testing Laboratories.

This is the first practical and exhaustive treatise on this important subject. It has already been adopted as a text-book by the University of Pennsylvania and other technical schools. Each chapter contains a minute description of the methods followed in the author's laboratory and many valuable suggestions as to the "how" and "why" of cement testing. The observations on the interpretation of results, one of the most difficult tasks of the novice, are especially pertinent and are expressed in a fair and conservative manner.

The book is so complete that it can be put in the hands of a young engineer with confidence that it will enable him to make reliable tests on cement. The wealth of photographs and line cuts furnish the pictorial examples of how to conduct cement tests, and the 300 pages of texts are so explicit that even the most inexperienced man can soon learn the art of cement testing. Yet the book has not a superfluous paragraph. The list of chapters includes: (1) Classification and Statistics, (2) Composition and Constitution, (3) Manufacture, (4) Inspection and Sampling, (5) The Testing of Cement, (6) Specific Gravity, (7) Fineness, (8) Time of Setting, (9) Tensile Strength, (10) Soundness, (11) Chemical Analysis, (12) Special Tests, (13) Approximate Tests, (14) Practical Operation, (15) Other Varieties of Cement than Portland, (16) Specifications (The Author's, Am. Soc. C. E.; Am. Soc. Test. Mtls.; Soc. Chem. Indust.; Corps Eng. U. S. A.; British Standard, Can. Soc. C. E.).

Cloth, 6x9 inches; 330 pages; 142 illustrations; 58 tables; $3.00 net, postpaid

The Myron C. Clark Publishing Company
355 Dearborn St., Chicago

Drawings and photographs are given of such a structure built by both the Vandalia Line and the Missouri, Kansas and Texas. In each case the costs of the structures are given.

Notes on Reinforced Concrete. By Arthur W. French, Jl. Worcester Pol. Inst., May, 1908; 12 pp.

Notes on the designing of tee beams are given. Also the requirements of the building codes in several cities as to designing concrete, are given in tabular form.

Reinforced Concrete Piles and Ties. Ry. & Eng. Rev., May 23, 1908; 1 p.

Abstract from a paper by A. C. Chenoweth before the N. Y. Railroad Club. Describes the making of a reinforced concrete pile by a rolling process without the use of forms, but in a yard fitted up for that purpose. Also gives the record of several driving tests of this pile, which is the invention of the author of the paper.

Concrete Pier at Santa Marie, Cal. Conc. Eng., May, 1908; 5 1-3 pp.

The pier consists of 3 and 7 pile butts carrying transverse girders and connected by longitudinal struts, the whole carrying a timber floor. This article illustrates the concrete pile and girder construction and gives an abstract of the specifications governing the work.

Reinforced Concrete in Electric Railway Construction. By N. M. Stark, St. Ry. Jl., May 2, 1908; 1½ pp.

This is an argument for and also a record of experience with the use of reinforced concrete bridges for electric railways. Some useful hints are given.

Reinforced Concrete Columns. By P. Gillespie and W. G. Swan. Applied Science, March, 1908; 13 pp.

Gives results of tests of reinforced concrete columns with full analysis of the figures obtained. The following conclusions were reached:

1. The employment of longitudinal steel reinforcement in concrete columns is not economical except where high working stresses in the concrete accompany a low value of Ec.
2. The hoops and spirals in the cases examined contributed little or nothing to the strength of the column beyond what could be explained by the presence of the longitudinal rods.
3. The hoops and spirals did not increase the rigidity of the concrete which they enclosed. These two phenomena may be explained by the fact that the pitch of the hoops was much greater than is considered good practice.
4. For columns up to 25 diameters, the tendency to fail by buckling under centrally applied loads is probably small.
5. For this particular class of concrete a modulus of elasticity of 1,500,000 for a stress of 500 lbs. per sq. in. seems to be a fair value.
6. The variation in the ultimate strength values of the separate columns would indicate the necessity of employing a fairly high factor of safety in the use of reinforced concrete columns for construction purposes.

Foundations: The Use of Driers and Grouting Machines. By Francis Fox, Ann Arbor, May 6, 1908; 6¾ pp.

Describes the method of repairing the foundations and masonry of Winchester Cathedral and other notable English buildings by forcing cement grout into the cracked masonry to solidify it and underpinning the walls. The grouting machine used is described and the general method of work is outlined.

Methods of Concrete Work on Florida & East Coast Ry. Viaduct. By H. R. Light, Am. Era, May, 1908; 4 pp.

Now Ready

CONCRETE CONSTRUCTION

METHODS AND COST

By

Halbert P. Gillette
M. Am. Soc. C. E., M. Inst M. E.,
Managing Editor, Engineering-Contracting

and

Charles S. Hill, C. E.,
Associate Editor, Engineering-Contracting.

THIS book handles the subject of concrete construction entirely from the view-point of the ***builder*** of concrete structures. The testing of cement, the physical properties of cements and concrete, and the design of concrete structures are not considered. The aim of the authors has been to eliminate all matter not germane to the constructing end of their subject. By doing this it has been possible to crowd a vast amount of detailed information on methods and cost of concrete construction into a volume of moderate size. The book is a treatise on the ***methods and cost*** of building in ***concrete.***

WHILE concrete design is not considered, no designer of concrete can be a really good designer without having a profound knowledge of costs and of practical methods of construction. This book will be of interest therefore to every engineer and architect who is engaged in designing concrete structures. It should be of particular assistance, however, to the contractor or engineer engaged in the actual work of making and placing concrete.

THE methods given are practical methods and they are so given that the practical man can use them. The costs given are actual costs, itemized, analyzed and reduced to units. Costs of material, costs of transporting, costs of mixing, costs of placing, costs of tamping, costs of finishing, costs of forms, costs of bending and placing reinforcement, costs of waterproofing, costs of superintendence, costs of plant, interest charges, depreciation charges are all given, and to make these costs useful, the conditions and the methods of doing the work are stated in each case.

Cloth, 6 x 9 inches, 700 pages, 306 illustrations, $5 net, postpaid.

The Myron C. Clark Publishing Co.
355 Dearborn St., Chicago, Ill.

Describes in some detail the methods and sequence of work in constructing concrete viaducts on the Florida & East Coast Ry., Key West Extension. A good general descriptive article.

Concrete Block Ordinance at Birmingham. Am. Era, May, 1908, 2 pp.

Gives nearly in full the text of the new Birmingham, Ala., ordinance governing concrete block building construction.

Concrete Floors. By H. M. Bains, Am. Era, May, 1908; ½ p.

Describes briefly methods of constructing concrete floors for various classes of buildings.

Tests of Coral Sand and Rock with Reference to their Use in Concrete. By Dewitt C. Webb. Eng News, May 14, 1908, ⅓ p.

Gives results of crushing tests of concrete cubes and bending tests of reinforced concrete slabs in which coral rock from vicinity of Key West, Fla., was used as sand and aggregate. The crushing strengths obtained at 75 days ranged from 516 lbs. to 764 lbs. per sq. in.

Immunity from Rusting of Reinforcing Steel in Concrete. Eng. News, May 14, 1908; ¾ p.

Gives results of tests made by E. Probst in Germany to determine danger of rusting of reinforcing steel by entrance of investure through ordinary tension cracks. The tests show that the ordinary tension cracks occurring within the limits of permissible loading do not permit the atmospheric corroding influences to affect the steel.

Light Three Hinged Concrete Arch Bridge in Rock Creek Park, Washington, D. C. Eng News, May 21, 1908; 1 p.

Shows general detail of 100-ft. span three-hinged, arch-rib bridge, with drawings of falseworks, and gives general description of construction. Pin connected hinges were used. Cross struts were constructed in trough section to hold earth for grooving rims.

Gravel Washing and Screening Plant for Concrete Dam and Power House Work. Eng.-Contr., May 13, 1908; ⅔ p.

Describes plant for excavating, washing and screening pit gravel employed by contractors for 117,000 cu. yds. of concrete dam and power house work near Rockingham, N. C. The cost of the washed and screened gravel loaded on cars was 60 cts. per cu. yd.

Method of Constructing Reinforced Concrete Underpinning for 14-Story Building on Line of Washington St. Tunnel, Boston, Mass.. Eng.-Contr., May 13, 1908; 1⅓ pp.

Describes methods of underpinning a 14-story building by sinking rectangular shafts lined with reinforced concrete slabs and filling with concrete. The shafts when completed proved a close foundation wall under the edge of the building adjacent to the tunnel.

Safe Design and Construction of Reinforced Concrete Chimneys. Eng.-Contr., May 20, 1908; 4½ pp.

Report of Sanford E. Thompson to Association of American Portland Cement Manufacturers, on chimney failures and their causes with discussion of and recommendations for safe design and construction.

Geology of the Lehigh Cement Belt. By F. B. Peck. Cem. Wld., May, 1908; 6 pp.

This article gives briefly the salient geological characteristics of the notable deposit of concrete rock in the so-called Lehigh District of Pennsylvania and New Jersey. Some account of the Meade proves of using this rock without admixture of pure limestone is given, and following this an outline of the general process of cement manufacture as practiced by Lehigh mills.

Designing for Reinforced Concrete. By R. H. Haas. Cem. Wld., May, 1908; 3 pp.

Though general in character this article gives some valuable suggestions on designing reinforced concrete from the viewpoint of economy of construction. Examples are given showing how slight changes in design reduce form costs and other expenses.

A Small Concrete Dam. By Samuel H. Lea. Eng. Rec., May 9, 1908; 1 p.

Describes a small concrete dam built for a light and power company in South Dakota. Describes the design, method of construction and gives a table of cost, showing the wages paid and the unit costs.

SURVEYING AND DRAFTING.

Panoramic Camera Applied to Photo-Topographic Work. By C. W. Wright. Eng. News, May 14, 1908, 3¼ pp

Describes the camera and its fittings, adjustment, method of platting maps from photographs, field-work, etc. The paper is a strong argument for the utility of this method of topographic surveying.

Planimeter Measurements of Areas on Maps. By J. C. Hoyt. Eng. News, May 21, 1908. ⅔ p.

Describes method of measuring areas on maps by planimeter.

Table for Relveation of Curved Boundaries. By Ernest McCullough. Eng.-Contr., May 13, 1908; ½ p.

Gives a table of deflection angles for use in relocating curved boundaries for lots where only radius and lot corners are given, with explanation of method of using table.

An Engineering Department Filing System. R. R. Gaz., May 8, 1908; ¾ p.

Tells of the method of filing drawings and blue prints in use in the engineering department of the Chicago & Eastern Illinois R. R.

Methods of Plumbing Deep Shafts. Min Sc., May 21, 1908; ½ p.

A letter describing the method of plumbing down a shaft 700 ft. deep, to project a line to connect another shaft located a mile away.

MATERIALS OF CONSTRUCTION.

Forest Products of the U. S. in 1906. Forest Service Bulletin 77; 100 pp.

In this book there is collected valuable information as to the output of our forests and the value of the products. The data have been completed under numerous heads, such as lumber, shingles, laths, cross ties, cooperage stock, pulp wood, tan bark, poles and wood for distillation. Under each of these heads the various kinds of wood are considered, and the different products made from them. Tables showing the amount of each class of material produced are given and the estimated values.

Preservation of Railroad Ties. By Samuel M. Rowe. Ry. Age, May 15, 1908; 2¼ pp.

A very practical article on methods of tie preservation, commenting upon the various processes in use, and the results obtained by them. Advocates the erection of treating plants by railroads.

Experiments on the Railway Cross Ties. Eng. Rec., May 16, 1908; 1 p.

An account of tests being made by the U. S. Forest Service in conjunction with the Northern Pacific R. R. as to the most economical methods of handling the timbers of the Northwest when manufactured into ties.

The Burlington Tie Preserving Plant at Galesburg. Ry. Age., May 8, 1908; 4 pp.

An article describing and illustrating with photographs and drawings the construction of this creosoting plant. The cost of the plant is given, and some results obtained in treating some ties, and the essential cost of creosoting a tie.

EARTH AND ROCK EXCAVATION.

Method and Cost of Blasting More than 3,500 Stumps. Eng.-Contr., May 13, 1908; ⅔ p.

An article telling of economical work in blasting stumps from waste lands, showing the costs in detail, and the amount of ex-

JUST PUBLISHED
A Valuable Book for
ENGINEERS, CONTRACTORS
and Engineering Students

Specifications and Contracts
By J. A. L. WADDELL, C. E., D. Sc., LL. D.
Author of "De Pontibus," etc
Including Examples for Practice in Specification and Contract Writing,
TOGETHER WITH

Notes on the Law of Contracts
By JOHN C. WAIT, M. C. E., LL. B.
Author of "Engineering and Architectural Jurisprudence," etc.
Cloth, 6 × 9 ins.; vi. + 174 pages Price, $1.00 net.

In these lectures, which were prepared for and delivered before engineering students, Dr. Waddell sets forth clearly and concisely the essential features of specifications and contracts from the engineer's point of view, illustrating his presentation of the various details by many citations from instruments drawn up by him during his extended professional career.

Following these lectures are forty examples, of diverse character, for practice in specification writing, and fourteen sets of conditions precedent for contracts to be drafted by students.

In the second part of the book Mr. Wait supplements Dr. Waddell's text by a discussion of the legal phases of the various topics considered in the lectures.

It is believed that this book, if used as a text-book by engineering students and by practicing engineers, will do more to perfect them in the practical writing of such documents than any other work or combination of works that can be suggested.

The unusually low price—one dollar—has been fixed upon in order that the book may attain the widest possible circulation among engineering and architectural students. While confessedly a work for students, there are, nevertheless, but few engineers and contractors who will not gain much information and many suggestions of value from its careful reading.

The reputations of the authors in their respective professions and as writers furnish abundant warrant for this belief.

A very complete index is included, and items may be quickly found by referring to the side heads printed on the margin of each page.

IN PREPARATION
(Ready at an early date)

CONCRETE SYSTEM
By FRANK B. GILBRETH
One of the Most Valuable Books for Engineering-Contractors Ever Published
Flexible morocco; 8½ × 11 ins.; 220 pages; 200 illustrations and plates.
Price, $5.00 net

General Outlines of "Concrete System."

This concrete system contains the written ideas of the most successful men in the organization of one of the most successful of American contractors, partaking of the nature of a set of specifications, telling HOW to do the work, economically, expeditiously, systematically and safely. The rules and instructions are those which have been used with satisfaction in Mr. Gilbreth's own work. They were written specially for the use of his own employees, as in the case of his "Field System," and to a great extent consist of a valuable portion of the "stock in trade" of his organization.

"Concrete System" is primarily a book of instructions to the employees of the author, giving the best practice in all departments, and containing the entire set of rules under which they work in all parts of the country. The strict maintenance of these rules, through which superintendents, foremen and timekeepers are trained in the "duplicate part" system, has contributed largely to the success of the author, by enabling him to make a specialty of "speed work."

The book is profusely illustrated with some 200 half-tone illustrations, the majority of them being full-page plates; many detailed and working drawings, organization charts, etc., all taken from actual work done by the author.

The flexible morocco binding will be strong and substantial; the price is as low as possible consistent with such a high-class publication.

Orders should be send us NOW and will be filled in the order received as soon as the book is off the press.

The Engineering News Book Dept.
220 Broadway, NEW YORK

plosive used to blast out stumps on 10 acres of land.

A Ditching Machine that Cuts a Ditch with Sloping Sides. Eng.-Contr., May 13, 1908, ½ p.

Describes a ditching machine with apron wheels for use in swamp lands, and by the use of skeleton buckets a ditch is cut with sloping sides.

Comparative Costs of Earthwork. By A. P. Davis. Eng. Rec., May 16, 1908; 1⅓ pp.

The cost of building reservoir embankments on reclamation projects in the west is given, showing fair units of cost including depreciation of plant used on the work and engineering and administration expenses. A comparison is made of the weather conditions at Boise, Idaho, and Albany, N. Y., showing that for a working season of eight months that 22 days can be worked per month in the east and 24 in the west. A comparison of the wages shows that the western wages exceed those paid in the east on this class of work by 39 per cent. The author says, "It seems safe to conclude that this class of work in the west costs necessarily from 25 to 50 per cent more than in the east, depending on locality." An article of interest to earth moving contractors and engineers.

Repairing a Dyke on the Southern Ry. R. R. Gaz., May 22, 1908; 1 p.

Describes the method of repairing a dike in the piles and willow mattresses, which instead of allowing the water to underwash the dike and destroy it, causes the river to deposit sand and weed on the mattress and help maintain the dike.

Machine for Digging Trenches or Canals, or for Scalping Large Areas and Loading Into Wagons. Eng.-Contr., May 20, 1908 ⅔ p.

Describes a machine that travels on platform wheels, that not only cuts a trench, but will widen it on each side. It can also be used for stripping earth from large area. The platform wheels admit of the machine traveling on very soft ground.

Development of the Air-Hammer Rock Drill. By Claude T. Rice. Eng. & Mng. Jl., May 23, 1908; 2 pp.

This article is based on a paper by Prof. J. Orr before the Transvaal Int. of Mech. Eng. New features of air hammer drill are described and illustrated, and the differences of the new styles from the old styles are pointed out.

Machine Drills for Stoping. By Eustace M. Weston Eng. & Min. Jl., May 23, 1908; 3 pp.

A discussion of the use of air drills for stoping and shaft sinking, with special mention of a new drill being used in South Africa known as the Konomax drill. Consideration is also given of air pressure that should be used in operating drills.

Experiments to Determine Physical Characteristics of Materials to be Used in the Gatin Dam. Eng.-Contr., May 13, 1908; ⅔ p.

Describes the experiments that are to be made, and various tests outlined to show if the materials at this dam site are suitable for the foundation work and also to be used in the construction of the dam.

Regrading of Seattle, Washington. Eng. Rec., May 9 and 16, 1908; 8 pp.

Describes the work being done to regrade a large area of the city of Seattle. The hills have been cut down by means of steam shovels and hydraulic sluicing. The methods used are described. In all 27,000,000 cu. yds. of earth are to be excavated.

The Electric Air Drill. By William L. Saunders. Eng.-Contr., May 27, 1908; 2⅓ pp.

Describes a new drill that is finding favor in many kinds of rock work. It is not an electric drill, but an air drill, and can be driven by air only, but as the transmitted power is electricity, it is given the name of Electric Air Drill. The electricity operates

The world's authority on this great subject.
The most expensive book ever issued and sold for $5.00.

Concrete and Reinforced Concrete Construction

By HOMER A. REID, Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; $5 net, postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete, on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter—material never previously published. This work is complete, up-to-date and original. No other book on concrete contains one-tenth so much of the very latest data on tests, theory and practice.

In a two-column review of this book, "Manufacturers' Record" says: "There seems to be no portion of concrete or reinforced concrete that has not been touched upon, and the thoroughness and carefulness with which the author has handled his subject should make it a valuable assistant to engineers, architects, contractors and those interested in concrete generally."

Write for 16-page Table of Contents.

THE MYRON C. CLARK PUBLISHING CO.

355 Dearborn St. **CHICAGO**

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, Chicago
Telephone Harrison [illegible]
New York Office 1521 Park Row
Telephone [illegible] Cortlandt

HALBERT P. GILLETTE . . . Managing Editor
DANIEL J. HAUER,
CHAS. S. HILL,
C. T. MURRAY,
F. A. SMITH, . . . Associate Editors
MYRON C. CLARK . . . . President
A. B. GILBERT . . . . Advertising Manager

SUBSCRIPTION RATES (Payable in Advance):—
$2.00 *a year (52 issues) in the United States, Mexico, [illegible], Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
$2.50 *a year (52 issues) to Dominion of Canada.*
$3 00 *a year (52 issues) to all other countries.*
ADVERTISING RATES sent on application.
Copy for regular advertising must be received not later than Friday preceding date of issue in which it is to appear. "Proposals," "Wants" and "For Sale" announcements can be inserted as late as Tuesday morning.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

Editorial:
- Roadways that Will Resist the Wheels of Automobiles....................351

Concrete Section:
- Concrete Caissons for Breakwaters and Quay Walls..................352
- Cost of a Concrete Manhole.........352
- Methods and Cost of Building a Concrete-Steel Culvert to Carry an Irrigation Canal Under a Creek Bed...353

Earth and Rock Section:
- Dredging Equipment on the Panama Canal 354
- An Interesting Bucket Elevator......356

General Section:
- Cost of Steel Sheet Piling for Concrete Dam, U. S. Reclamation Service 357
- Data on Macadam Road Construction at Easton, Pa.....................357
- A Cost Keeping System for Street Improvement Work........ 360
- Hints on Fillers for Brick and Block Pavements 360
- The Use of Wood Piles Driven at an Angle in Dock Construction.......362

Methods and Costs:
- Road Roller Maintenance—Clipping a Hole Through a Concrete Dam—Buoy for Marking Oyster Bed Corners—Data on Concrete Curb Construction—Drilling Holes in a Well Lining—Tree Planting in 1907 in Massachusetts 358

Letters to the Editors:
- Methods of Filing and Indexing Trade Catalogs and Working Drawings...359

Catalogs Worth Having..............362

Personals: 362

Roadways That Will Resist the Wheels of Automobiles.

Several theories have been advanced to account for the rapid disintegration of macadam roads under automobile traffic. A few years ago when we first began to hear rumors about the destruction of macadam roads in France, due to the sucking action of the pneumatic tires, we were all inclined to be skeptical. We had seen nothing of the kind in this country as a result of bicycle travel, and automobiles were then too few in America to enable us to judge what they might do when they should become more numerous. But, except in parts of the United States where automobiles are relatively scarce, or where macadam roads are scarcer, there is no longer any doubt that the wearing surface of the old fashioned macadam road must be radically changed if not done away with entirely when subjected to automobile traffic.

One of the editors of this journal recently examined the macadam roads in Central Park, New York City, where conditions are unusually favorable for the maintenance of macadam. These roads, until very recent years, have always been kept in perfect condition by constant repairs and constant sprinkling. The automobiles have effected a wonderful change. Here and there are long ruts—we call them ruts for want of a better name—which the soft tired wheels have cut in the seemingly solid stone. How have they done it?

The raveling or rutting of the macadam is not due to chains on the tires, for chains are absolutely forbidden within the park limits. Nor is the rutting due to high speed traffic, for the eight mile an hour limit is enforced by the numerous policemen in the park, as well as by the congested condition of the roads which makes speeding impossible.

Clearly, then, these causes so commonly cited as the reasons for macadam disintegration, are of relatively minor importance.

Surface sprinkling with oils has served to keep down the dust, and has unquestionably prolonged the life of macadam in Central Park, but has not prevented "rutting." It is clear, therefore, that surface sprinkling must be supplemented by something else eventually, although surface sprinkling may always be necessary to maintain any sort of macadam subject to heavy automobile travel. What shall this supplemental construction be?

Before the cure is found the cause must be known. The cause of the disintegration of macadam under automobiles is precisely the same as the cause of its disintegration where exposed to high, dry winds and to the pounding of hoofs and wheels. It has been known for a hundred years that macadam ravels quickly if the stone dust that binds the broken stone together is swept away more rapidly than it is formed. It is the mortar made of stone dust and water that cements a macadam road into a solid mass—nothing else. This mortar is rather weak, it is true, but, if not removed by the wind or otherwise, it serves well enough. Now, under automobile travel, this mortar is picked out from between the stone by adhesion to the rubber of the tires probably aided by some suction. Then the wind created by the low hung moving body of the automobile sweeps the dust away.

The ruts made in macadam in this manner are curious in that there is no considerable depression formed, but the broken stone is left lying loose, all the binder (the dust that makes the mortar) having been picked out and swept away.

Clearly there is but one way to prevent this destruction and that is to mix some sort of bituminous mastic, such as asphaltic oil, or some tar product, with the macadam. If this must be done, the question immediately arises as to the necessity of using any broken stone at all. Why not bind the soil itself together with an asphaltic or tar product? As a matter of fact, this is being done successfully. Some soils, it is true, do not make a durable wearing coat when treated in this manner, although there is no soil that cannot be made into a solid monolithic mass sufficiently dense for a base or foundation. In such cases, having made a substantial base of natural soil with asphaltic or tar as the cement, well compacted, a top coat of asphalt or tar macadam is placed upon this base to resist the direct wear of the wheels. This wearing coat need not exceed 2 ins. in thickness, corresponding to the thickness of an asphalt pavement when laid on a 6-in. base of concrete.

According to press reports, the Los Angeles County Highway Commission is discussing the advisability of building macadam roads. It seems strange to an Eastern engineer to hear that a section of the country whose oiled roads have secured a world wide fame is about to take a step backward. Doubtless many of their roads are not all that they should be, but this is clearly due to the primitive methods that have been used, and to the ridiculously low cost. Contracts for the very best oiled highways in Southern California have never exceeded 27 cts. a square yard! Yet many of them are wonderfully fine specimens of the roadmaker's art even at this price.

Before the Los Angeles County Highway Commission trys the experiment of worshiping foreign gods, it would do well to inquire a little further as to what the "foreigners" think of those gods.

State highway commissions and engineers in the East are trying all sorts of experiments with macadam, from surface sprinkling with oil and tar to actual ripping up of the old macadam and relaying it with cements of asphalt or bitumin of one kind or another. The dust nuisance has be-

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

come intolerable. France and England are likewise turning to asphalts and tars for relief.

California, with heavy asphaltic oil at 1½ to 2 cts. a gallon, is in a position to secure the finest highways in the world at the smallest cost. If it is found that some natural soils do not make a sufficiently good wearing coat when mixed with asphaltic oil, then the expenditure of a few more cents per square yard for a thin wearing coat of asphaltic macadam is clearly the most economic solution of the problem. Old John Macadam himself has said that a layer of macadam only 2 ins. thick is sufficient for the wearing coat of a highway, provided it is supported by a properly drained and consolidated base. Following his idea, then, the base can be made of any natural soil cemented and compacted together with asphalt or tar, upon which a 2-in. wearing coat of asphalt or tar macadam is laid. This wearing coat should not be made of fragments of stone all of one size, but the fragments should be graded in size down to dust, so that the percentage of voids is reduced to a minimum.

In sections of the country where stone is cheap and asphalt or tar is expensive, undoubtedly the old fashioned macadam will continue to be used as the base, but upon this base will be laid a wearing coat of asphalt or tar macadam, as just described. Whereas in sections where asphalt or tar is cheap or where stone is expensive, stone will be used only for the wearing surface (2 ins. thick), if it is used at all.

This we believe is the consensus of opinion among all engineers who have had wide experience in road building and have given this problem careful study.

Amherst, Nova Scotia, is supplied with electric power and light generated from the waste products of a coal mine.

In a news note in our issue of May 20, giving some data on the cost of Tarvia work at Easton, Pa., we erroneously stated that for each square yard of surface covered 3 gallons of Tarvia was used. This should have read three-tenths gallon.

The cost of maintenance of macadam roads in Mercer County, N. J., for the year 1907 was as follows: Average cost per mile (actual length) of macadam repairs for the year, for the entire system, $307.42; average cost per mile (equivalent length for width of 14 ft.) of macadam repairs for the year, for the entire system, $299.87; average cost per mile (actual length) of all other repairs for the year, for the entire system, $71.53; average cost per mile (actual length) of maintenance, including tools and machinery, for the year, for the entire system, $402.18; average cost per mile (equivalent length) of maintenance, including tools and machinery, for the year, for the entire system, $692.29.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Concrete Caissons Used for Breakwaters and Quay Walls.*

In Europe extensive use is being made of hollow concrete cassions, both plain and reinforced, for breakwaters and quay walls. The structure is towed into position and sunk, after which the hollow cells are filled. Some of these used for breakwaters weigh more than 5,000 metric tons.

At Rotterdam, caissons 131.2 ft. long, and having a width of 32 ft. at the base and 16 ft. at the top, and 43 ft. high, were being used. A middle division wall through the length, and nine cross-walls, divide the caisson into twenty cells. Four such caissons were built at the same time in an improvised dry dock. The first step was the preparation of a base, about 2 ft. thick and 32 by 131.2 ft., well reinforced, and in this were embedded the vertical rods for the walls. The external side walls, about 14 in. thick over the base, were carried up with a batter. When the caisson walls were up to about five-eighths of their final height, the gates were opened and the caissons were floated out to a place in the harbor where they were secured to mooring piles. There they were completed, meanwhile being afloat for one or two months.

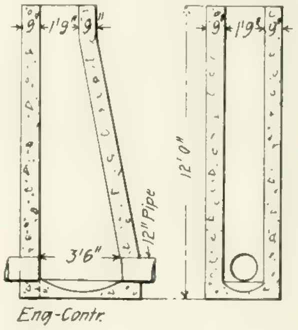
As there are streaks of peat in the soil at Rotterdam, the bad parts are removed by a dredge, and then the dredged cut is filled with sand at least 6 ft. deeper than the base of the caisson. Then the caisson is towed into place, and, by means of a tongue, and groove on the ends, the floating mass is brought into alignment, the free end being controlled by tackle. Next, by opening valves, the caissons are sunk on the prepared bed of sand, after which the water is pumped out of the front row of cells and these are filled with concrete; the rear row of cells is filled with sand to save expense.

In the older construction, the side was dredged, then a brush-mattress facing was placed, and this was allowed to stand for one or two years to secure thorough settlement of the mass on and to the rear of the mattresses. Afterward wood piles were driven through the mattress and, by using a special diving bell, were cut off and capped below low water; then they were decked with wood or reinforced concrete upon which was built the quay wall. The floating, reinforced concrete caisson method was stated to cost less per linear foot than for piles decked with concrete and more than for piles decked with wood. Practically, the cost may be said to be the same, with the decided advantage of a nearly monolithic wall.

Where rock is convenient, this method might be used with advantage: Having made the dredged cut, next place along the front line of the caisson one or more rows of piles, which might be driven to, or cut off, say, 2 ft. below, the grade of the bottom of the caisson; and then rock fill to grade; the object of the piles covered by rock would be to prevent any rotation of the concrete block around the outer toe due to a thrust from the shore side.

Cost of a Concrete Manhole.

The following figures of the cost of constructing a concrete manhole are rearranged from the "Canadian Engineer." The construction of the manhole is clearly



shown by the accompanying sketch. About the only point that need be noted is that the form lumber was so cut up that it could not be used again and its total cost is therefore charged against the work. The costs were as follows, there being 4.08 cu. yds. of concrete in the manhole:

Materials.	Total.	Per cu. yd
300 ft. B. M. lumber at $30.	$ 9.00	$2.21
5 bbls. cement at $2.25.....	11.00	2.69
4 cu. yds. sand and gravel at $1	4.00	0.98
Total materials	$24.00	$5.88
Labor:		
Forms, 70 hrs. at 32½ cts.	$22.75	$5.57
Mixing and placing concrete: 13 hrs. at 22½ cts.........	2.92	0.71
Total labor	$25.67	$6.28
Total labor and materials.	$49.67	$12.16

---

*Abstracted from a paper in the Proceedings American Society of Civil Engineers, Vol. XXXIV, entitled "Notes Upon Docks and Harbors," by Luther Wagoner. The paper is to be presented before the society Sept. 2, 1908.

Methods and Cost of Building a Concrete-Steel Culvert to Carry an Irrigation Canal Under a Creek Bed.

BY HENRY A. YOUNG.*

The structure was built during the months of March, April and May, 1906, the gravel and sand having been hauled during the winter months preceding.

The culvert consists of a single barrel, 10 ft. by 7 ft. 6 ins. 121 ft. long, heavily reinforced with plain square bars. The barrel connects with the canal section at each end by warped walls, the entrance being 16 ft. long, connecting with a canal section 14 ft. 6 ins. wide on the bottom, with 1½ to 1 slopes, the outlet end being 18 ft. long, connecting with a canal section 20 ft. wide on the bottom, with 1½ to 1 slopes. The canal section at the outlet end was riprapped for a distance of 10 ft., with 12 in. stones on side and bottom.

The creek passing over the culvert was of fair size, subject to heavy floods in the spring. A new channel was made to the culvert partially in excavation and partially of filled banks. These banks were carried across the culvert.

The excavation for the structure proper was rather difficult, it being almost entirely in gravel, and requiring considerable hand work, though slip teams removed the bulk of the material. After about half of the total excavation had been completed it became necessary to install a 6-in. centrifugal pump to remove the water entering through the gravel.

Gravel and sand were obtained from pit about ¼ mile distant, the haul being down grade. Material was screened to required size in a bin at the pit. The cost per yard recorded includes cost of work in pit and hauling to structure site.

In back filling, the portion on the lower or river side of the culvert was filled with coarse gravel, while that on the upper side was puddled.

The coarse gravel consisted of the larger stones screened out at the gravel pit and the costs cover the expense of hauling the gravel from the waste pile at the pit and placing it at the structure.

A Chicago Improved Cube 1/3 cu. yd. mixer was used, it being placed about 25 ft. to one side of the center of the culvert. Water was supplied by a gasoline pump, pumping from the Yellowstone river, about 50 yards distant into an elevated tank nearby.

Concrete was put in very wet and spaded with flattened spades. A 1-in. course of 1-2 motar was placed on floor, roof, copings and tops of walls. Chamfer strips were used on all sharp corners, and fillets at corners of barrel.

Cement, steel, lumber, and other materials were hauled from railroad, about ¼ mile distant. All labor consisted of 8-hour days.

The work consists of 2,083 cu. yds. of excavation, 369 cu. yds. of reinforced concrete, mixed in the proportion of 1-2¼-5½, and some puddling, riprap and gravel fill.

All cement and steel were furnished by the company. The bending of steel and pumping were paid for as extra work.

Some of the costs may seem large when compared with eastern prices, but it must be remembered that common labor was paid 25 cts. an hour and the rest in proportion; that the work was out on the prairie, though near a railroad, and that nearly all materials had to be brought from the east.

It will be noted that form lumber was charged up at one-third of its cost, as it was used on other structures later.

The costs for hauling, handling, bending and placing steel bars can be taken as accurate, as particular pains were taken to subdivide these charges carefully.

Puddling consisted in hauling back part of the excavated material in slips and working the material with wooden bars. As water rose around the structure as soon as pumping was stopped, the contractor had all the water needed for puddling without going to extra expense.

The cost of quarrying and hauling the riprap is large, because the quarry was about four miles from the structure and the work done by inexperienced labor.

The data given are the summation of the actual construction charges, covering all labor and materials used on the work, and the necessary field supervision. They do not include the contractor's charges for office expenses, bond, insurance, plant depreciation, camp, freight, etc., but they do include the hauling to and the installing of the plant on the site.

Classification	Days.	Rate	Total	Rate per Yard.
Excavation, Class I, 2,083 cu. yds.				
Excavating and backfilling				
Superintendent	23¼	$166.67	$129.17	
Foreman	39½	50.00	65.83	
Blacksmith	10⅛	2.40	24.30	
Laborers	8	2.40	19.20	
Laborers	239⅝	2.00	479.25	
Two horse team and teamster	41⅛	4.00	164.50	
Two horse team and teamster	78⅜	3.60	282.15	
Excavating 2,083 cu. yds. (wet gravel).			$1164.40	$0.56
Pumping water out of excavation:				
Superintendent	¾	166.67	4.17	
Foreman	⅞	50.00	1.46	
Blacksmith	¾	2.40	1.80	
Engineer	6¼	2.00	12.50	
Engineer	49⅛	2.40	117.90	
Engineer	41¼	3.20	132.00	
Laborers	27½	2.00	55.00	
Two horse team and teamster, hauling coal	1⅝	4.00	6.50	
Labor (2,083 cu. yds. excavation)			$331.33	0.16
Lumber, 1,594 ft. B. M.		19.25	30.69	
Coal, 5½ tons		2.65	14.58	
Coal, 4½ tons		2.90	13.05	
Cylinder oil, 4 gals.		0.44½	1.78	
Engine oil, 6 gals.		0.31	1.86	
Pump diaphragm			1.75	
Materials (2,083 cu. yds. excavation)			$63.71	0.03
Concrete, Class II, 369 cu. yds.				
Forms, building and removing:				
Superintendent	2½	166.67	13.89	
Head carpenter	43¼	3.20	138.40	
Carpenters	113	2.80	316.40	
Carpenters	100¾	2.40	241.80	
Laborers	3⅜	2.40	8.10	
Laborers	76⅝	2.00	153.25	
Two horse team and teamster, hauling materials	6¼	4.00	25.00	
Labor, building and removing forms (369 cu. yds. concrete)			$896.84	2.43
Lumber (at ⅓ cost), 27,300 ft. B. M.		6.42	175.27	
Nails, 5¾ kegs		3.70	21.28	
Wire, 200 lbs.		0.0364	7.28	
Wire, 70 lbs		0.03	2.10	
Materials for forms (369 cu. yds. concrete)			$205.93	0.56
Pumping water out of culvert to remove barrel forms:				
Superintendent	3½	166.67	19.44	
Engineer	7¼	2.80	20.30	
Laborers	⅛	2.40	.30	
Laborers	9⅜	2.00	18.75	
Two horse team	4⅛	2.00	8.25	
Coal, 3 1-5 tons		2.90	9.28	
Kerosene, 1 gal.		.25	.25	
Cylinder oil, 1 gal.		.44½	.45	
Engine oil, 1 gal.		.31	.31	
Labor and materials (369 cu. yds. concrete)			$77.33	0.21
Installation of concreting plant:				
Superintendent	9½	166.67	52.78	
Foreman	1½	50.00	2.50	
Head carpenter	3¼	3.20	10.40	
Carpenters	3¼	2.80	9.10	
Laborers	11⅞	2.00	23.75	
Two horse team and teamster	7	3.60	25.20	
Labor (369 cu. yds. concrete)			$123.73	0.33
Mixing and placing concrete:				
Superintendent	19¾	166.67	109.75	
Foreman	13⅛	50.00	21.88	
Fireman	17⅛	2.40	41.10	
Cement worker	23¼	80.00	62.00	
Blacksmith	19½	2.40	46.80	
Laborers	3⅝	2.40	8.70	
Laborers	217¾	2.00	435.50	
Water boy	8¾	.50	4.37	
Saddle horse (superintendent's)	6⅛	1.00	6.13	
Two horse team and teamster hauling supplies	13	4.00	52.00	
Labor (369 cu. yds. concrete)			$788.23	2.14
Cement, 440¼ bbls.		1.86	818.87	
Gravel, 335 cu. yds.		1.057	354.10	
Sand, 145 cu. yds.		1.057	153.27	
Coal, 3 tons		2.65	7.95	
Coal, 6 tons		2.75	16.50	
Gasoline, 35 gals.		.25	8.75	
Cylinder oil, 3½ gals		.44½	1.56	
Engine oil, 4 gals.		.31	1.24	
Cup grease, 7 lbs.		.09	.63	
Materials (369 cu. yds. concrete)			$1362.87	3.69
Reinforcement:				
Hauling:				
Superintendent	¼	166.67	1.39	
Foreman	1¾	50.00	2.92	
Laborers	2½	2.40	6.00	
Two horse team and teamster	2⅝	4.00	10.50	
Labor, hauling steel (369 cu. yds. concrete)			$20.81	0.06
Bending bars:				
Superintendent	3	166.67	16.67	
Foreman	5½	50.00	9.17	
Blacksmith	3¾	2.40	9.00	
Carpenters	¼	3.20	.80	
Cement worker	2⅞	80.00	7.68	
Laborers	20½	2.00	41.00	
Labor (369 cu. yds. concrete)			$84.32	0.23
Placing bars:				
Foreman	6⅜	50.00	10.63	
Carpenter	2⅜	3.20	7.60	
Carpenters	2½	2.40	6.00	
Blacksmith	1¼	2.40	3.00	
Laborers	35⅛	2.00	70.25	
Labor (369 cu. yds. concrete)			$97.48	0.26
Steel bars (369 cu. yds. concrete), 47,531.7 lbs.		0.0288	1368.91	3.71
Total cost of concrete per cu. yd. in place				$13.62

---

*Engineer in charge of water-works, Camagüey, Cuba.

Classification	Days	Rate	Total.	Rate per Yard.
Puddling, 114 cu. yds.:				
Laborers	10	$2.00	$20.00	
Two horse team and teamster	9⅜	4.00	37.50	
Labor (114 cu. yds. puddling)			$57.50	.50½
Coarse gravel, 153 cu. yds.:				
Laborers	33⅛	2.00	66.25	
Two horse team and teamster	16¾	4.00	67.00	
Labor (153 cu. yds. coarse gravel)			$133.25	.87
Riprap:				
Quarrying and hauling, 19 cu. yds.:				
Laborers	20½	2.00	41.00	
Two horse team and teamster	11¼	3.60	40.50	
Labor (19 cu. yds. riprap)			$81.50	4.29
Placing stone:				
Cement worker	2¼	$0.00	6.00	
Laborers	1¼	2.20	2.75	
Laborers	17¼	2.00	34.50	
Labor (19 cu. yds. riprap)			$43.25	2.28
Total cost of riprap.			$124.75	6.57

SUMMARY.

Excavation, Class I, 2,083 cu. yds.

Excavating and backfilling	$1,164.40	$0.56
Pumping water out of excavation—Labor	331.33	0.16
Pumping water out of excavation—Materials	63.71	0.03
Total cost of excavation	$1,559.44	0.75

Concrete, Class II, 369 cu. yds.

Forms, building and removing:		
Labor	$ 896.84	2.43
Materials	205.93	.56
Labor and materials, pumping water out of culvert	77.33	.21
Installation of concrete plant	123.73	.33
Mixing and placing concrete, labor	788.23	2.14
Mixing and placing concrete, materials	1,362.87	3.69
Reinforcement:		
Hauling steel	20.81	.06
Bending bars	84.32	.23
Placing bars	97.48	.26
Steel bars, 47,531.7 lbs	1,368.91	3.71
Total cost of concrete in place	$5,026.45	13.62
Puddling, 114 cu. yds	$ 57.50	.50½
Coarse gravel, 153 cu. yds	133.25	.87
Riprap, 19 cu. yds	124.75	6.57
Total cost of structure	$6,901.39	

Note:

Cost of hauling bars, per lb	$0.0004
Cost of bending bars, per lb	0.0018
Cost of placing bars, per lb	0.0020
Cost of steel bars, per lb	0.0288
Total cost per lb. in place	$0.0330

The cost of the plant for the construction of the Isthmian Canal down to March 31, 1908, amounted to $27,969,526. The distribution of this amount among various departments of the work is shown in the following table:

New buildings (all departments)	$ 9,127,524.97
Rolling stock	6,415,100.72
Floating equipment	3,951,875.67
Excavating machinery	2,548,749.26
Shop, other machinery and tools	1,215,208.15
Rails, fastening and ties	1,841,745.62
Relocation of Panama railroad	1,104,701.56
Second main track, Panama railroad	765,380.17
Docks and wharves	484,462.16
Construction of electric light plant	151,772.58
Lands purchased	59,341.35
Corral equipment	3,664.25
Total	$27,969,526.46

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

Dredging Equipment on the Panama Canal.*

BY F. B. MALTBY.

The writer during a connection of about two and a half years with the Isthmian Canal Commission, most of which time was spent on the isthmus, had charge of the design, construction, maintenance and operation of the dredge plant employed, and it is proposed to give a brief description of this machinery.

There are in use or being built four distinct types of dredges of entirely different characteristics: First, the old French ladder dredges; second, American dipper dredges; third, sea-going suction dredges; fourth, pipe-line suction dredges.

The so called old French ladder dredges are those which the Americans fell heir to when the canal property was purchased from the French canal company. There were some sixteen or seventeen of these dredges, of the endless bucket type. They vary somewhat in detail, but are all of the same general construction. The digging apparatus consists of an endless chain of buckets holding about 14½ cu. ft. each. This chain of buckets is carried by a box girder hinged at the top and of sufficient length to enable the dredge to work to a depth of about 30 ft. The buckets discharge into chutes leading over the side of the dredge and into barges alongside.

The chain of buckets is driven with a pair of steeple compound condensing engines, which are conected with the top tumbler wheel either through gearing or by friction wheels and large sprocket chains. Steam is supplied by Scotch marine boilers working under a pressure of 70 to 80 lbs. The hulls are of genuine wrought iron, not steel, and some of them were supplied originally with propelling machinery, but this has been taken off. The hauling and hoisting winches are simple but cumbersome and 1¼-in. chain is used for hoisting the ladder as well as for moving and maneuvering the dredge. No quarters were provided for the crews. These dredges were built either in Belgium or in Scotland. Some of them had been pretty well worn out and were of little value. Most of them were in a remarkably good state of preservation, although most of them had not been in use for at least eighteen years. The woodwork was entirely rotted away and required renewing throughout. The machinery had been carefully laid up and painted and had been well cared for. It required only cleaning up, packing of joints and occasionally a rod needed truing up. The hulls, on account of being wrought iron, had corroded very little and were practically as good as new.

One of these old dredges was rebuilt at Cristobal and put into operation in May, 1905, and a second one was afterward rebuilt and repaired. The Panama R. R. Co. was operating one at the Pacific terminus and it was turned over to the Canal Commission in June, 1905, and a second and a third one have been rebuilt at that end.

These dredges of the non-propelling type have hulls of rectangular shape, about 114 ft. long, 32 ft. wide and 12 ft. deep. The engines operating the chain of buckets are of about 180 h. p. and are operating condensing. These dredges have no means for breaking up the material to be excavated other than the buckets themselves, and consequently their digging capacity or the ability to force the buckets into hard or compact material is not very great. For these reasons their capacity per day varies with the material to be excavated.

At La Boca, the Pacific terminus, there are two of these dredges in operation, working 24 hours per day and six days in the week. During the month of October, 1907, one of them removed 143,222 and the other one 143,885 cu. yds., an average of about 5,300 cu. yds. per day. The maximum daily output in November was 6,907 cu. yds. and 7,556 cu. yds. respectively. The material handled is mud with a very considerable portion of sand, very easily excavated and handled with this type of dredge. During October, 1907, one of this same type of dredges removed 133,064 cu. yds. from the new channel in Limon Bay, or the Atlantic terminus. The reduced output below that of the dredges on the Pacific side is due to a greater seaway on the Atlantic side and also to the fact that the mud encountered is softer, and while it is easier to excavate, it is so soft that it will not pile up in the buckets and more or less is lost during the passage of the buckets through the water. The capacity of these dredges excavating in coral rock is reduced by about one-half. The material excavated is taken out to sea and dumped into deep water, the length of haul varying from two to four miles.

The dredges are served by self-propelling hopper bottom dump barges, which are also a part of the old French equipment that has been rebuilt. These barges have a hopper capacity of about 225 cu. ft. long and are driven by twin screws and compound condensing engines. The hopper doors are operated by hand winches.

---

*Abstracted from Proceedings of The Engineers' Club of Philadelphia for January, 1908.

The operation of these old dredges has been rather surprising and very satisfactory. Their machinery, though cumbersome, is very simple, and very little trouble has been experienced through breakdowns. The buckets have cast steel backs with ¾ or ⅞ steel fronts and bottoms riveted to them. They have an extra cutting tip or edge of 1-in. steel. The eyes in the links and bucket backs forming the chain are bushed with steel and have steel pins. These bushings and pins wear very rapidly, but their renewal is a very simple and inexpensive matter.

The bearings for the lower tumbler wheel, which are constantly working in sand and grit, also wear very rapidly; the journal boxes are of cast steel and made solid and without any provision for taking up wear. They are usually allowed to run till the boxes are nearly or quite worn through on the bottom.

The cost of handling material with these dredges, including the cost of operation, superintendence, all running repairs and the cost of operating the barges, is between 9 and 10 cts. per cu. yd., though monthly costs have gone as low as 5 cts. per cu. yd. This cost does not include any proportion of first cost or depreciation or the first cost of extensive rebuilding.

It is evident that for excavating soft material to a moderate depth this type of dredge has certain advantages that are not appreciated in this country. They are very similar to the gold dredges that have been so extensively and successfully used throughout the West.

The second type of dredge in use is the dipper dredge. This is strictly an American type of dredge and was originated and has been used in this country to a greater extent than any other type in use. They can be briefly described as a steam shovel gone to sea, as they have all the characteristics of a steam shovel with the parts made usually much heavier and with a radius of action greater than a steam shovel. Three of this type of dredge have been built and are in operation on the canal, one on the Pacific side and two on the Atlantic side. Two of them were built by the Atlantic, Gulf & Pacific Dredge Co., after designs made by A. S. Robinson, and the other one by the Featherstone Foundry & Machine Co. All three are of the same size and general construction. Steel has been used throughout, except in the spuds and dipper handle, which are of wood, the latter lined with steel angles and plates.

They have steel hulls 110 ft. long, 37 ft. wide and 9½ ft. deep, and are proportioned to excavate to a depth of 40 ft. of water. They have dippers with a capacity of 5 cu. yds. for excavating in sand or mud and have extra dippers of 3 cu. yds. capacity and fitted with very heavy manganese steel teeth, to be used for continuous operation in rock.

The main engines operate the hoisting and backing drums and also the drums for handling the spuds, while the swinging is done with an independent engine. They are equipped with independent capstan engines and electric light plants. Steam is supplied by Scotch marine boilers at a working pressure of 150 lbs. The booms are of very heavy construction and about 52 ft. long and are carried directly on the turntable without any overhead gallows frames. The spuds are of Oregon fir, 60 ft. long. On two of the dredges these are single sticks 36 ins. square, while on one of them the spuds are built up and are 42 ins. square. The main hoisting lines are crucible steel cables leading direct to the dipper without the intervention of any purchase blocks, and all sheaves over which the line passes are 6 ft. in diameter. On two dredges two cables, each 1⅝ ins. and laid side by side, are used, while on the other one a single cable 2¼ ins. in diameter is used.

The engines, gearing, and drums are proportioned to give a pull on the hoisting line of about 90,000 lbs. These dredges were built under general plans and specifications prepared by the writer, the details being left to the builders.

The principal advantage of this type of dredge lies in its ability to dig in hard material. It has been found quite possible to excavate coral rock without blasting, though the progress of the work is expedited by a small amount of shooting to loosen up the ledges and to permit the dipper to get a better hold on the rock. A somewhat smaller crew is required than on a ladder dredge, though the operator must be a much higher paid man, as the capacity of the machine in any given material depends almost entirely on the ability of the operator to keep it in constant and rapid operation.

Owing to some mechanical defects the operation of these dredges has not been as entirely satisfactory as was hoped, though I understand that these have been remedied to a very large extent. They cost about $102,000 apiece delivered on the isthmus. During 20 days in the month of October, 1907, one of these dredges removed 70,000 cu. yds. from the channel at the Pacific terminus, while the maximum daily output in November was 4,456 cu. yds.

The third type of dredge, and possibly the most important, owing to their size and cost, in use on the canal is the sea-going suction dredge. Two of this type have been built, one for each terminus, and one of them has been in operation at Colon since September, 1907. The second one, the "Culebra," reached La Boca under her own steam December 28, 1907, after a voyage of about 12,000 miles, much of it through heavy weather.

These dredges are designed to operate in the harbor entrances to the canal and are therefore built self contained and are able to work in a considerable seaway. In general design they are very similar to the dredges "Manhattan" and "Atlantic," in use in excavating the new American channel to New York harbor, and to the dredge "Delaware," in use in the Delaware river. They differ from these dredges in the detail of their dredging machinery and also in their equipment and arrangement of quarters.

Their hulls are of steel, 274 ft. long between perpendiculars and 288 ft. long over all, with moulded beam of 47½ ft. and depth of 25 ft. The hull framing is made in accordance with the rules of the American Bureau of Shipping for vessels of class A. 1. They have twin screws and are propelled by compound condensing engines 22 x44x30 ins. stroke.

The dredging machinery consists of two 20-in. single suction centrifugal pumps direct connected to compound condensing engines runing at from 160 to 170 revolutions per minute, and at these speeds developing from 440 to 460 I. H. P.

The centrifugal pumps are located on each side of the ship a little aft of amidships. They have inclosed cast steel runners about 72 ins. in diameter with 6 blades about 19 ins. wide. The suction from each pump passes through the side of the ship a little below the loaded water line and is joined to the suction pipe through a swivel elbow. The suction pipe is 20¼ ins. inside diameter, ⅜ in. thick, and the sections are joined together by forged steel flanges welded onto the pipe. These flanges and the welded point have a greater strength than the pipe itself. The suction pipe is about 63 ft. long over the suction shoe and the dredge can excavate to a depth of 40 ft. of water. The pumps discharge into sand bins having a nominal capacity of about 2,000 cu. yds. Steam is supplied by four Scotch marine boilers 14 ft. in diameter, 12 ft. long, under a working pressure of 150 lbs.

The dredges are equipped with the usual condensers, pumps, and auxiliary machinery, and in addition have electric lights, evaporators, and a complete ice-making and refrigerating plant.

The dredges are entirely self contained and are able to operate for a week or more with the coal and stores which they will carry.

Quarters are provided for a crew of about 57 men. The details of the dredging machinery, sand bins, and arrangement of quarters, etc., were designed by the writer, while the general construction follows that of the dredges previously mentioned. They were built by the Maryland Steel Co., at Sparrows Point, Md., and cost about $724,000 for the two.

The operation of the one now in commission has been most satisfactory, and there is every reason to believe that the second one will be equally as successful. On their tests they handled from 1,600 to 1,700 cu. yds. of sand and mud per hour.

The centrifugal sand pumps carried a

vacuum on their suction side of from 26 to 28 ins. Their nominal capacity is about 2,000 cu. yds. per hour in clean sand or sand with only a small proportion of mud.

The trip from Sparrows Point to Colon, a distance of 1,906 miles, was made in eight days and nine hours, including about half a day that she was hove-to on account of a storm, or an average of 9½ knots per hour.

The dredge is operated for 24 hours per day for 5½ days per week, Saturday afternoon being used for coaling and taking aboard stores.

During the month of September, with a green crew and new machinery, 266,000 cu. yds. measured in place was excavated in the harbor at Colon; in October 273,500 cu. yds. and in November 304,000 cu. yds.

The material is mud and does not readily settle in the bins, though it is very readily excavated. By actual measurement it has been found that the pumps have handled as high as 87 per cent of solid material. The length of haul to the dumping-ground is two to three miles. In commenting on the work of the dredge during September the "Canal Record" estimated that the excavation and disposition of the same amount of material from Culebra cut would have required the work of 14 steam shovels, 30 locomotives and work trains, and about 1,500 men. The crew of the dredge consists of 57 men.

The fourth type of dredge to be used in the canal is the pipe line suction dredge, or a suction dredge which deposits on shore, through a pipe line, the excavated material. The French company had several small dredges of this type, used for rehandling material, but they were never very successful in operation on account of the design of the pumps.

These pumps had suction and discharge pipes 16 ins. in diameter. The pump runner was about 24 ins. in diameter and had blades about 4 ins. in width. These proportions will perhaps be better appreciated by comparing them with a pump for the same sized discharge pipe which was put onto one of these dredges which had a runner 69 ins. in diameter with blades 11 ins. wide inside the shroud.

One of these small dredges was rebuilt and a pump of the size just mentioned put on it. This dredge has been used in filling material into the low ground adjacent to Colon and in opening a channel in the old canal between Cristobal and Gatun, portions of which had been filled up. The material from the channel was pumped ashore.

It is proposed to build the great Gatun dam by the hydraulic method or by pumping the material into place. The hydraulic method of dam construction is not new and has been extensively used in the west, but usually in localities where flowing water with a source at sufficient elevation is available for transporting the material. It should, however, make no difference in the success of construction of this nature whether the water is secured from mountains under a sufficient head to give the necessary velocity for transportation or this velocity is given by pumps. For this purpose two dredges are being built, which will first borrow as much material as can be had within reasonable distance of the dam, and will then re-handle and pump into the dam material excavated from the canal and brought to the site in dump barges.

These dredges are of steel, 135 ft. long by 36 ft. wide and 9 ft. deep. They have a single 20-in. pump with double suction, driven by a pair of tandem compound condensing engines developing about 450 I. H. P. The suction pipe is provided with a cutter driven by an independent engine. The cutter and supporting frame are very heavily built and braced and designed for excavating very stiff clay. The discharge pipe is carried on floating pontoons to the shore line and from there to the point of discharge is laid on the ground.

It is not expected that it will be possible or advisable to pump material into the dam and up to the full height with a single pump. It has been found that about 75 ft. head against a sand pump is about the economic limit, as beyond that the necessary peripheral velocity of the pump runner becomes so high that the wear is abnormal. By "head" is meant the total head against which the pump is operating, and will consist of friction in the pipe, velocity head, and the actual lift or static head.

When the head has reached the maximum economic limit it is proposed to use a relay pump. This will be a pump similar to the one on the dredge, but motor driven, and will thus not require any steam plant or foundation, and but little attendance. It will be placed at the end of the discharge pipe, which will lead directly into the suction side of the pump. Its discharge pipe can be extended till the head on the second pump has reached the same limit, when another pump can be added, and this repeated as often as necessary.

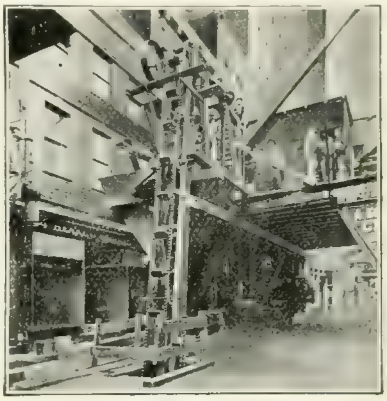
It is, however, improbable that more than two pumps on one line will be needed. These dredges have not been completed and are not in operation. Two of them are also being built for the construction of the dams at the Pacific end of the canal, as proposed by the Board of Consulting Engineers. The Canal Commission has just recommended the construction of locks at Miraflores instead of La Boca, which will obviate the necessity of dams near La Boca, but will necessitate the excavation of several miles of sea-level canal, for which work these dredges are admirably suited.

As tending to show the relative capacity of the dredging plant I have described, I will refer to the amount of excavation during the month of November, 1907. During this period the three ladder dredges, three dipper dredges, and one sea-going suction dredge excavated and removed 792,000 cu. yds., while the total amount removed by steam shovels from the Culebra division was 788,000 cu. yds., or the seven dredges removed 4,000 cu. yds. more than 42 shovels. Of the total amount dredged, 304,000 cu. yds. was taken out by the dredge "Ancon," which is at the rate of nearly 600 cu. yds. per hour for every working hour she was in commission during the month. The average amount excavated per day of eight hours per shovel is 784 yds., or 98 cu. yds. per hour.

An Interesting Bucket Elevator Delivering Wet Clay and Sand Into Bins Which Discharge Into Wagons.

We illustrate herewith a bucket elevator that is 110 ft. long between centers, and has a 5-ft. "lap-over" at the top so as to discharge the material into the center of a bin.

The elevator is operated at a speed of 250 ft. per min., with buckets spaced 20 ins. apart. The material is discharged from dump cars into a "boot" at the foot of the elevator. Each bucket has a capacity of 15 lbs., and, at the rate of 150 buckets per min., the capacity is 60 cu. yds. per hour.


Bucket Elevator.

The speed of 250 ft. per min. is noteworthy, and is due to the special design of the link chain.

This particular plant is one installed for removing the excavated material from the North River Tunnel, built by the Hudson River Railroad Co. The installation is one of several made for the same company by the Link Chain Belt Co. of New York City.

The sundry civil appropriation recently passed by Congress contains a provision authorizing the Interstate Commerce Commission to investigate and experimentally test at its discretion any appliances intended to promote the safety of railway operation. Under this law it is expected that the inventor or owner of any device intended to promote safety upon railroads may submit plans and specifications and receive an opinion as to its merits, to be followed by a test if advisable.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Cost of Steel Sheet Piling for Cofferdam for Concrete Dam U. S. Reclamation Service.

The cost of 140 26-ft steel sheet piles in place is given by the June "Reclamation Record." The piles were driven to an average penetration of 22 ft.

The type of piling is that manufactured by the Carnegie Steel Company for the United States Steel Piling Co., of Chicago. The piling cost at the factory is 70 cts. per lin. ft., and as its weight is 35 lbs. per running foot, the cost therefore was 2 cts. per pound. The freight rate from the factory at Pittsburg to Whalen, Wyo., was $1 per 100 lbs., thus making the total cost f. o. b. cars at Whalen, about $1.05 per lin. ft.

The line of piles under consideration was driven in August, 1907, and forms a part of the south side of the cofferdam used in the construction of the concrete diversion dam on the North Platte river, at the head of the Interstate canal. None of the piles were driven under water, and the material into which they penetrated consists of sand and coarse gravel. The piles were dragged from the railroad siding to the river bank, and carried across the river on cables. The pile driver outfit used was a Lidgerwood single drum 20 H. P. hoisting engine and a 2,800-lb. hammer, having an average drop of 8 ft. When no hindrance occurred by accidents to the machinery, the average number of piles driven per twelve hours was 27, with an exceptionally high run on August 9 of 29.

The regular pile-driving crew consisted of one foreman, one engineer and four laborers. Each of these men received 35 cts. an hour for his work except in transporting the piles from the railroad station to the driver, in which case the laborers were paid for at the rate of 25 cts an hour and teams at the rate of 20 cts. per hour. The total labor cost of unloading and moving the piles from the railroad to the driver was $53.25, making a unit cost per linear foot of pile of $0.015. The total labor cost for driving was $190.05, making a unit cost of $0.052 per linear foot of pile.

Below are tabulated the total and unit costs of the piles in place distributed under the headings of plant depreciation, labor, materials and supplies. The depreciation on the engine was about 2 per cent of its original cost, while that on the driver was about 30 per cent of its original cost, including repairs made on it. The charge for materials contains in addition to the piling and freight thereon, $28 worth of wood fillers used in connection with the piling The charges under supplies consist of coal and oil for the engine and labor for carrying drinking water. Six tons of coal were used, at $5.50 per ton.

Distribution of costs.	Total cost.	Unit cost per pile.	Unit cost per foot of pile.	Unit cost per foot of penetration.
Plant depreciation.	$60.00	$0.416	$0.016	$0.019
Labor	243.30	1.742	0.067	0.079
Materials	3,850.00	27.508	1.058	1.250
Supplies	44.18	0.312	0.012	0.014
Total	4,197.48	29.978	1.153	1.362

Data on Macadam Road Construction at Easton, Pa.

During 1907 the city of Easton, Pa., constructed 22,104 sq. yds. of new macadam streets at a total cost of $9,626 or an average of $0.4355 per sq. yd. The work was done by the city force under the general supervision of Mr. John McNeal, City Engineer, from whose report the matter in this article has been taken.

Crushed limestone was furnished by contract for $0.90 per ton of 2,000 lbs., delivered on the streets, and trap rock was also furnished by contract for $1.58 per ton of 2,000 lbs., delivered on the streets. The approximate weight of limestone per cubic yard measured loose was 2,700 lbs.

The wages paid were as follows: Foremen, 25 cts per hour; laborers, 20 cts. per hour; road-roller engineer, 30 cts. per hour; two horse team with driver, 50 cts per hour.

The average cost of rolling with 12½ ton steam roller was $4.44 per day, or a total cost of $887.79. This cost included wages of engineer, gas coal at $5 per ton delivered, repairs, oil and packing. The average cost of surface rolled was 2½ cts. per square yard.

The unit cost of water for sprinkling was $0.04 per tank of 300 gallons. The sprinkling cart is owned by the city and $0.50 per hour is paid for team used with it. The amount used, of course, depended largely upon the condition of the weather. Some streets required less sprinkling than others on account of rains during construction. For instance, on High street, which was macadamized with limestone for a depth of 10 ins., and an area of 1,000 sq yds., 53 tanks of water were used, or 15.9 gallons per square yard of surface. On Bushill street, macadamized with crushed limestone for a depth of 6 ins. and an area of 1,748 sq. yds., 98 tanks of water were used, or 16.8 gallons per square yard of surface.

The cost of macadamizing several streets, the thickness of macadam as given being the measure in place after rolling, was as follows:

HIGH STREET.

(Macadamized with limestone for a depth of 10 ins. a length of 800 ft. and a width of 30 ft., 1,000 sq. yds.):

	Total.	Per sq. yd. pavement.
Grading	$15.30	$0.015
Limestone, 450.9 tons	405.84	.406
Spreading	29.00	.029
Sprinkling	14.12	.014
Rolling	33.29	.033
Total	$497.55	$0.497

BUSHHILL STREET, 2D TO 3D STREETS

(Macadamized with limestone base and trap rock wearing surface for a depth of 8 ins., a length of 500 ft. and a width of 30 ft., 1,667 sq. yds.):

	Total.	Per sq. yd. pavement.
Grading	$ 53.25	$0.032
Limestone, 442 tons	397.78	.238
Trap rock, ¾ in., 99 tons	156.42	.094
Spreading	48.80	.029
Sprinkling	15.78	.010
Rolling	62.15	.037
Total	$734.18	$0.440

ST. JOHN STREET

(Macadamized with limestone for a depth of 6 ins., a length of 722 ft., and a width of 18 ft., 1,444 sq. yds.):

	Total.	Per sq. yd. pavement.
Grading and filling with spalls	$112.82	$0.079
Limestone, 263.4 tons	237.06	.164
Trap rock, 20 tons	31.60	.022
Spreading	27.95	.019
Sprinkling	19.00	.013
Rolling	15.54	.010
Total	$443.97	$0.307

KLEINHAUS AVENUE.

(Macadamized with limestone for a depth of 8 ins., a length of 500 ft., and a width of 18 ft., 1,000 sq. yds.):

	Total.	Per sq. yd. pavement.
Hauling and spreading spalls for filling	$173.90	$0.174
Limestone, 190.4 tons	171.36	.171
Spreading	19.45	.020
Drain pipe	22.38	.022
Sprinkling	9.00	.009
Rolling	31.07	.031
Total	$427.16	$0.427

The actual working force on the Isthmian Canal on the last day of April, as compared with the last day of March, was as follows:

	March.	April.
Gold force	4,996	4,950
Colored laborers	15,149	15,802
European laborers	5,407	5,366

Methods and Costs; Some Old; Some New.

Road Roller Maintenance.—The Massachusetts Highway Commission had in 1907 16 steam rollers. The rollers were used 1,087.5 days on town work in 28 different towns. They were also used 331 days on State highway repair work, on 42 different roads; 220 days by towns contracting for the building of State roads, including the "small town" roads; 169.5 days by private contractors on State highway contracts. The total number of days' work during the year was 1,808—an average of 113 days for each roller. The total cost of maintenance for the year was $2,539.69. Of this amount, $1,888 was paid for practically rebuilding two of the rollers, Nos. 1 and 2, which have been in active service since 1896; and $651.69 was expended for the ordinary repairs. Including the expense of supervision and inspection of the rollers, the average cost of such ordinary repairs has been 99½ cts. per day for each roller in use.

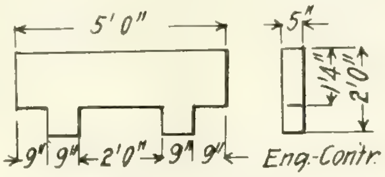
Chipping a Hole Through a Concrete Dam.—A compressed air plug drill and 1½ in. flat chisels were used in cutting a circular hole through a concrete dam for a flood waterway. The dam was built ten years ago, the concrete being composed of crushed shale and a mixture of Rosendale and Portland cement. The concrete seemed to be soft and tough rather than hard and brittle. Chipping by 1 in. flat chisels did not work satisfactorily but the wider 1½ in. chisels seemed to be suited to the material. When the hole was cut the dam was 16 ft, thick, the invert being 2½ ft. above the rock creek bottom. The hole is 5⅓ ft. in diameter for the downstream, 13 ft. of its length and 6 ft. in diameter for the last 3 ft. near the upstream end of the dam. The hole was cut at an average rate of exactly 1 ft. per 9-hour day, using a single drill with air at 70 lbs. pressure. Two laborers alternated in holding the drill and plenty of sharp chisels were kept ready so that there was no delay. The chisels were sunk into the concrete until the repeated blows of the plug drill hammer caused a piece to break out. From a few seconds to five or ten minutes were necessary to break out a piece of the concrete. As the men became accustomed to the drill they used at times a wedging method by sinking two or three chisels into the concrete along a line calculated to loosen a large piece containing perhaps ½ cu. ft. of material. This method worked well, especially when the lower portion of the hole was advanced ahead of the upper portion. The work was described by Mr. E. W. Schoder in a recent issue of Engineering News, from which the above note has been taken.

Buoy for Marking Oyster Bed Corners.—The Maryland Shellfish Commission, whose duties include the locating and mapping of all the natural oyster beds lying under the waters of the state, uses a specially constructed buoy for making the official oyster bar corners. The buoy consits of a seasoned cypress tree, barked and worked up in buoy shape, to the large or butt-end of which is bolted or lag-screwed a U-shape buoy iron. Concrete anchors weighing from 300 to 800 lbs., having a U-shaped ¾-in. staple embedded in the concrete when made, are used to maintain the floaters in place. A short section of ¾-in. or ½-in. chain (according to size of buoy and weight of anchor) is used to connect the buoy and stone. This chain is made fast to the staple and buoy iron by simple split links. This type of buoy is used in water of all depths over 10 ft.

Data on Concrete Curb Construction.—The concrete curb shown in the accompanying cut was built at an average labor cost of 6 cts. per lin. ft. The labor force employed on the work was as follows:

	Total.
8 laborers at $1.75	$14.00
1 finisher at $3.00	3.00
I working foreman at $4.00	4.00
Total	$21.00

This force averaged 350 lin. ft. of curb per day of ten hours. For the body of the curb, 1¾ yds. gravel and 7 sacks of Portland cement in a batch would make 60 lin. ft. of curb. Cement cost 60 cts. per sack; the gravel cost 75 cts. per cu. yd., and hauling cost 50 cts., making total cost of gravel $1.25 per cu. yd. On this basis the cost of materials for the body of the curb was 10.6 cts. per lin. ft. For the outside finish a batch was made of 18 pails of gravel screened gravel mixed with 4 sacks (12 pails) of Portland cement. The frames are to be of 2-in stock. For the above information we are indebted to Mr. A. W. Saunders, of Johnstown, Pa.



Sketch of Concrete Curb.

Drilling Holes in a Well Lining.—In an attempt to secure a more copious supply, an artesian well, lined with 12-in. pipe, was sunk to a greater depth through the water bearing stratum. The attempt proved futile and it became necessary to return to the original spring as a source of supply. The lining of the boreholes, however, had cut off the water, necessitating tapping the tube from the inside at the level of the spring. This was done by drilling a number of 1-in. holes through the tube to admit the water. The method of doing the drilling was as follows: Two drills were mounted horizontally opposite each other, a bevel wheel being keyed to each drill spindle. A third wheel was fitted to a vertical spindle, which was attached to boring rods. The inner ends of the drill spindles were threaded and on each was fitted a mitre wheel, forming a nut. Another mitre wheel on the vertical spindle meshed with these two. The gear ratio of the mitre wheels was different from that of the bevel wheels used to drive the drills, and accordingly when the boring rods were rotated the drills revolved at a different speed to the nuts and were fed up to the work. The whole apparatus was enclosed in a cylindrical case.

Tree Planting in 1907 in Massachusetts.—At the end of 1907 the Massachusetts, Highway Commission had planted 11,929 trees along the state roads. A part of these, however, have taken the place of trees which have died, or have been destroyed. The actual number now standing is 10,300; the difference represents the losses from all causes. The cost of planting new trees in 1907 was $.85 each, a sum less than 1906, the difference being partly accounted for by the fact that the trees planted in the fall had not yet received the mulching generally given. The cost of maintenance in 1907 for the trees previously planted was $0.23 per tree; including the cost of replaced trees, $0.28. The following table shows the number and varieties of shade trees planted in 1907:

	Replaced.	New Planting.
Elm	150	684
Norway Maple	205	608
Sugar Maple	38	138
White Maple	110	78
Ash-leaved Maple	10	31
White Ash	106	316
Green Ash	..	223
Oriental Plane	15	17
Russian Willow	95	31
Laurel-leaved Willow	9	13
Lombardy Poplar	10	..
English Oak	6	...
Pin Oak	31	..
Red Oak	57	...
Linden	2	..
Black Locust	..	33
White Pine	..	100
Total	844	2,272

Contracts have been let for another rapid transit subway in New York city. The new subway is in Brooklyn borough and extends along Fourth avenue from the Manhattan bridge to Forty-third street, about three and a half miles. The successful bidders are: Section 1, James P. Graham; Sections 2 and 3, William Bradley; Sections 4 and 6, E. E. Smith Contracting Co.; Section 5, Tidewater Building Co., and Thomas E. Bryson. The total of the contract prices for the entire work is about $16,000,000, of which about $1,000,000 is for pipe-galleries.

LETTERS TO THE EDITORS.

Methods of Filing and Indexing Trade, Catalogues and Working Drawings.

Sirs: Mr. Henry E. Baker's letter in your June 3rd issue brings up one of the most unsatisfactory and difficult propositions an engineering office has to deal with, namely: the filing and preserving of catalogues.

A number of years ago the "American Machinist" advocated a standard size of 6 x 9 ins. and multiples and subdivisions thereof for catalogues and while an increasing number of firms are adopting this size, the majority still adhere to a miscellaneous size possibly for the purpose of utilizing some existing cut or existing stock of mailing envelopes. If such firms realized the percentage of miscellaneous sized catalogues which go into the waste basket they would either adopt standard sizes or save the money invested in those they do send out.

Until there is more uniformity in size, the matter of filing catalogues must remain one of individual preference and convenience. The matter of indexing, however, is one which does not depend on the size and we have found the following method very convenient.

By the use of a two-drawer card index in one of which the cards are arranged alphabetically under firm name and in the other alphabetically under the name of the product or products described in the catalogue. For example, under Allis-Chalmers we find engines both steam and gas, air compressors, mining machinery, milling machinery, etc., whereas under the respective head in the other division of the index will be found the above classes of machinery with Allis-Chalmers' name as manufacturers. Each catalogue on its receipt is given a number and in both indexes is referred to by this number. In this way it is very easy to find the products of a given manufacturer and the number and consequent location of his catalogue or, on the other hand, the manufacturers of a given product and the consequent number and location of their respective catalogues.

Akin to the standard sized catalogue problem is the standard sized drawing problem. This we have solved by adopting a sheet 24 x 36 ins. as standard and multiples and subdivisions of same as conditions might require. For ordinary shop and machinery drawings 24 x 36 ins. will be found large enough for the majority of assembly drawings, whereas 18 x 24 ins. and 12 x 18 ins. will cover a large majority of partial and sectional views and the larger details. For shop detail drawings 9 x 12 ins. with one piece on each sheet makes a very convenient size and where the scale required would be too small on this sized sheet, 12 x 18 ins. is used. For shop use the blue prints are mounted on heavy card board or light sheet iron and given a coat of white shellac. These sizes make the filing problem both in the office where tracings are filed flat in cabinets of suitable size and in the shop where the drawings are carried in suitable sized racks very convenient.

All drawings should be numbered consecutively and a card index, preferably in duplicate, be kept up to date, one side arranged alphabetically by machine name, the other arranged consecutively by drawing number.

While it requires considerable time and effort to inaugurate and keep up these card indexes the time will be saved many times in the facility with which a certain drawing or catalogue can be located.

A little united effort on the part of those responsible for the making of catalogues and drawings would go a long way toward removing some of the thorns from the path of the engineering and manufacturing public.

Yours very truly,
W. M. Dollar.
Buffalo, N. Y., June 5, 1908.

Sirs: I have for a number of years kept a very satisfactory file of catalogues and other pamphlets. The papers are placed in 9 x 12-in. filing boxes which open at the top and side; they are very convenient and are made by the Library Bureau of Boston. The boxes are numbered in accordance with the Dewey system of classification as used in libraries. I also keep clippings in envelopes numbered in the same manner. A card index is kept in connection with the above, but for ordinary matter it is not necessary to file a card as the Dewey index shows at once where all matter on the subject can be found.

I have found it advisable to subdivide the engineering subjects as given in the Dewey Index and as fast as one filing box is filled, a new box is added with a subdivision number, the pamphlets themselves being given the correct subdivision number when filed.

For instance, a pamphlet on brick paving is given the number 625.82 and is filed in the box numbered 625.8 (which is the number covering the general subject of paving). When the original box is filled a new box is added and given the number 625.82 and everything in relation to brick pavements is placed in the new box.

It will be readily seen that any possible expansion is provided for by readily devised modifications of this system.

Yours truly,
F. W. Dalrymple.
Bayonne, N. J., June 5, 1908.

Sirs: I am glad to note the inquiry (in your issue of June 3, 1908) of Mr. Henry E. Baker, City Engineer, Watertown, N. Y., relative to the size of catalogues.

I think you are in error when you say that the size most commonly used is 6 x 9 ins. This was true several years ago when one of the prominent societies advocated three standard sizes, of which 6 x 9 ins. was one.

Since then the vertical system of filing has made much progress, and the tendency now is to make catalogues the same size as ordinary letter heads. In this connection the perversity of mankind is very evident. Instead of using a certain size of letter head we have 8 x 10½ ins., 8⅛ x 10⅝, 8¼ x 10¾, 8⅜ 10⅞ and 8½ x11 ins.

These vagaries are caused by the makers of paper, two sizes being made, 16 x 21 and 17 x 22 ins. These sizes being cut up make the numerous sizes given above. Originally the letter size was 8½ x 10½ ins., this size being three-quarters of the old standard size, 8½ x 14 ins., cut from paper 17 x 28 ins.

All the old forms used to be folded to 3½ x 8½ ins., and forms were ordinarily multiples of this size. When the first typewriter was made, it would only take paper 8 ins. wide, which was the entering wedge for a unification in the larger sizes from which the smaller ones were cut to save waste. Hence we have now a multiplicity of sizes, which are without "rhyme or reason."

Take the U. S. Geological Survey. This uses 8 x 10½ ins for all blanks, the New York State Engineer office uses 8½ x 9¼ ins., the New York City Water Supply uses 8½ x 11 ins. and so on *ad infinitum*. ENGINEERING-CONTRACTING would be doing a good work to bring out uniformity in all this chaos.

One advantage in using say 8½ x 10½ ins. for catalogues is that the sheets are the same size as the letter head, and in correspondence individual sheets can be folded in with letters. And again the blank backs of separate catalogue sheets can be written on and used as letter heads.

Upon a little study it must become evident to the most obtuse that *standard* sizes of letters, catalogues, etc., would be a desirable feature, but as long as we all have our cranky notions uniformity in this matter seems a long ways off.

Let any one go to a printing office and note the endless variety of sizes in blank forms, letter heads, catalogues, and he will be convinced that the above criticism is not far-fetched.

This even applies to our engineering journals. No two of them are of the same size: Note ENGINEERING-CONTRACTING, "Engineering News," "Railroad Gazette," "Engineering Magazine."

I trust that ENGINEERING-CONTRACTING can bring about a reform.

Yours truly,
Emile Low, M. Am. Soc. C. E.
606 Ashland Ave.,
Buffalo, N. Y., June 6, 1908.

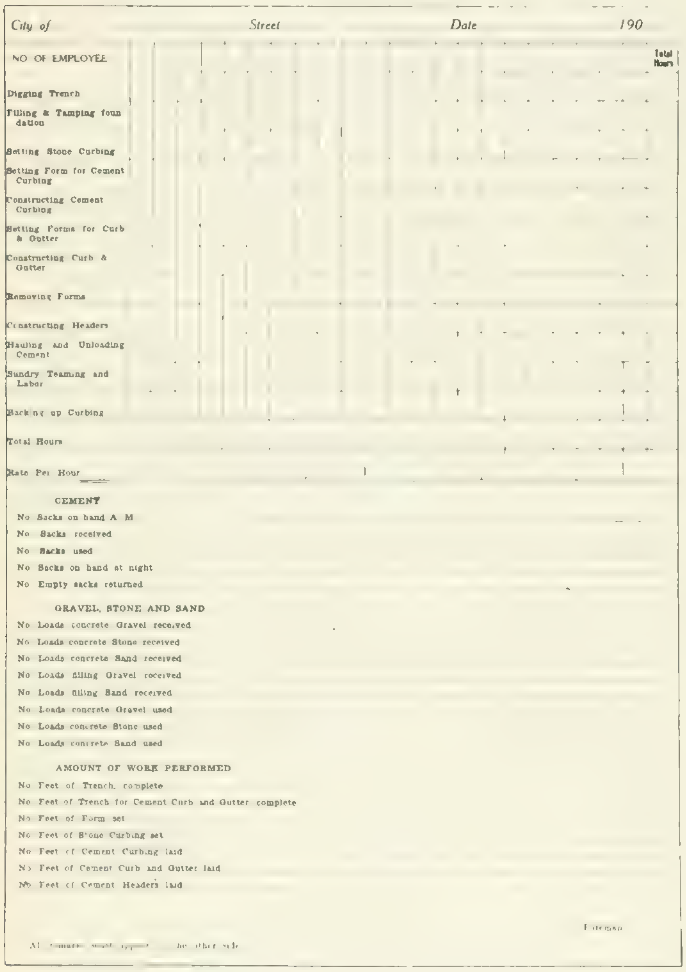
Contractors for railroad work in Nova Scotia are using oxen to a considerable extent in grading the roadbed, especially where the work calls for short hauls.

A Cost Keeping System for Street Improvement Work.

The accompanying illustrations show the set of blanks used by Kaumeier Bros., general contractors, Port Huron, Mich., for the purpose of keeping records of their paving work. Figure 1 shows a blank used for a daily curbing report. This work is always in charge of a separate foreman and consequently a separate report is made. Figure 2 shows the blank used for a daily time sheet. Stiff folders with a loose binder so that the cover folds back straight are used to hold these blanks. The blanks are taken out by the foreman onto the work, and whenever a man is changed from one class of work to another the foremen simply mark the time under its proper classification, and when the blank is turned in at night the number of hours worked is put on in ink, as shown in columns 1 and 2 of Fig. 2. It will be noticed in Fig. 2 that employe No. 1 worked from 7 to 9 at plowing, from 9 to 11 in rolling subgrade and so on. It takes the foreman but a second to note the time, as he always has his folder handy. All other clerical work is done at the office.

Figure 3 shows the blank used for a daily report. This daily report is a recapitulation of all work performed during the day, as well as of all material received. This report must be filled out by the foreman each night as to the amount of work performed and material received. All other work, such as cost data, is figured out in the office. Under this method it can be observed each day as to whether the foreman is getting efficient work out of his men or not, and is a good way of demonstrating to him where they are falling behind and where an improvement can be made.

The card shown in Fig. 4 is a teaming card, and one of them is given to each teamster. The letter "O" is used to note the time of arrival of the team and the letter "X" the time of departure. The letter "S" is used to indicate that the team drew a load of stone; the letter "G" indicates a load of gravel and the letters "Sd" a load of sand. In the card shown in Fig. 4 it will be observed that the team arrived at 7:10 and departed at 7:16, arriving back on the second trip at 8:04 and departing at 8:12. This card should be left with the teamster so that he can call the checker's attention to it each trip. If this is not done the checker is apt to mark the card wrongly, but with the teamster carrying the card there will be no trouble about its being marked each trip, for he will naturally be anxious to get in his right number of trips.



City of Street Date 190

NO OF EMPLOYEE Total Hours

Digging Trench
Filling & Tamping foundation
Setting Stone Curbing
Setting Form for Cement Curbing
Constructing Cement Curbing
Setting Forms for Curb & Gutter
Constructing Curb & Gutter
Removing Forms
Constructing Headers
Hauling and Unloading Cement
Sundry Teaming and Labor
Backing up Curbing
Total Hours
Rate Per Hour

CEMENT

No Sacks on hand A M
No Sacks received
No Sacks used
No Sacks on hand at night
No Empty sacks returned

GRAVEL, STONE AND SAND

No Loads concrete Gravel received
No Loads concrete Stone received
No Loads concrete Sand received
No Loads filling Gravel received
No Loads filling Sand received
No Loads concrete Gravel used
No Loads concrete Stone used
No Loads concrete Sand used

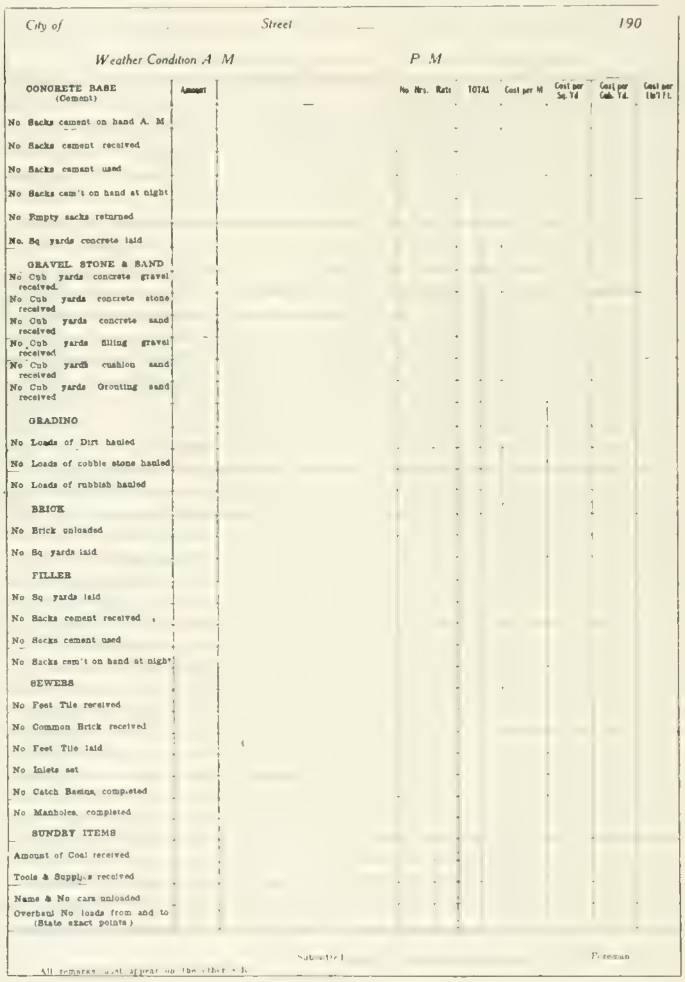
AMOUNT OF WORK PERFORMED

No Feet of Trench complete
No Feet of Trench for Cement Curb and Gutter complete
No Feet of Form set
No Feet of Stone Curbing set
No Feet of Cement Curbing laid
No Feet of Cement Curb and Gutter laid
No Feet of Cement Headers laid

Foreman

All remarks must appear on the other side

Fig. 1—Blank Used for Daily Curbing Report.



City of Street 190

Weather Condition A M P M

CONCRETE BASE (Cement) Amount No Hrs. Rate TOTAL Cost per M Cost per Sq. Yd Cost per Cub. Yd. Cost per lin'l Ft.

No Sacks cement on hand A. M
No Sacks cement received
No Sacks cement used
No Sacks cem't on hand at night
No Empty sacks returned
No. Sq yards concrete laid

GRAVEL, STONE & SAND

No Cub yards concrete gravel received
No Cub yards concrete stone received
No Cub yards concrete sand received
No Cub yards filling gravel received
No Cub yards cushion sand received
No Cub yards Grouting sand received

GRADING

No Loads of Dirt hauled
No Loads of cobble stone hauled
No Loads of rubbish hauled

BRICK

No Brick unloaded
No Sq yards laid

FILLER

No Sq yards laid
No Sacks cement received
No Sacks cement used
No Sacks cem't on hand at night

SEWERS

No Feet Tile received
No Common Brick received
No Feet Tile laid
No Inlets set
No Catch Basins completed
No Manholes completed

SUNDRY ITEMS

Amount of Coal received
Tools & Supplies received
Name & No cars unloaded
Overhaul No loads from and to (State exact points)

Submitted Foreman

All remarks must appear on the other side

Fig. 3—Blank Used for Daily Report.

Hints on Fillers for Brick and Block Pavements.

C. G. ATWATER.*

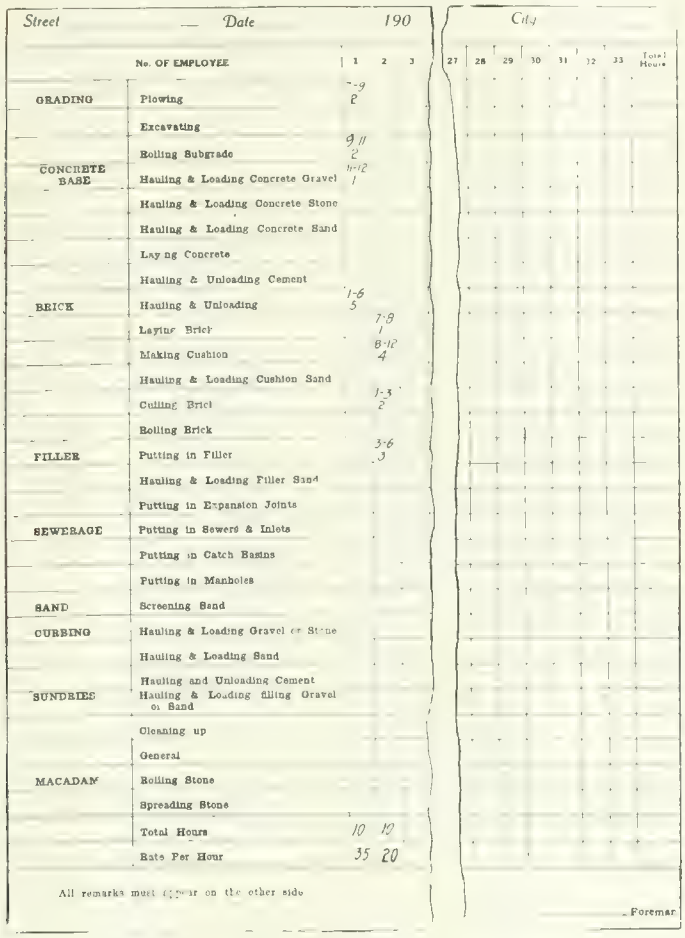
The subject of the proper filler for paving is of increasing interest. A filler to give satisfaction must first of all bind the bricks or blocks tightly together so as to give a continuous waterproof surface that will prevent water from passing through to the foundation. It must also take care of the expansion and contraction of the blocks themselves incident to changes in temperature. The question of protecting the top edges of the bricks or blocks is only incidental, as there is comparatively little wear at these points where a good quality of brick or stone is used, and that little is a great aid to traffic, as it gives the horses a proper footing.

However, when a poor quality of brick is used, a good grout filler does to some extent protect the edges of the brick, and thus prevents chipping, but one of the greatest objections to a grout filler is that it makes a continuous slippery hard surface, and this is particularly noticeable on streets having an appreciable grade. A grout filler is also very rigid and does not allow for any appreciable amount of expansion or contraction of the pavement, with the result that it soon bulges or cracks, leaving permanent openings through which water penetrates to the foundation.

---

* 17 Battery Place, New York.

Theoretically, expansion joints of bituminous material provide for expansion and contraction, but in practice cracks frequently occur and bulging is not uncommon where expansion joints are used. The perfect filler is one that permits all blocks to be set as close together as the lugs or letters will permit, that provides in each joint for the expansion or contraction that may take place in each block, that permits each block to rest entirely on the foundation, that provides a perfectly water-tight pavement at all times of the year and that gives just sufficient roughness to the surface so that horses get a footing.



Street	*Date* 190					*City*						
	No. OF EMPLOYEE	1	2	3	27	28	29	30	31	32	33	Total Hours
GRADING	Plowing	7-9 2										
	Excavating											
CONCRETE BASE	Rolling Subgrade	9-11 2										
	Hauling & Loading Concrete Gravel	11-12 1										
	Hauling & Loading Concrete Stone											
	Hauling & Loading Concrete Sand											
	Laying Concrete											
	Hauling & Unloading Cement											
BRICK	Hauling & Unloading	1-6 5										
	Laying Brick		7-8 1									
	Making Cushion		8-12 4									
	Hauling & Loading Cushion Sand											
	Culling Brick		1-3 2									
	Rolling Brick											
FILLER	Putting in Filler		3-6 3									
	Hauling & Loading Filler Sand											
	Putting in Expansion Joints											
SEWERAGE	Putting in Sewers & Inlets											
	Putting in Catch Basins											
	Putting in Manholes											
SAND	Screening Sand											
CURBING	Hauling & Loading Gravel or Stone											
	Hauling & Loading Sand											
SUNDRIES	Hauling and Unloading Cement											
	Hauling & Loading filling Gravel or Sand											
	Cleaning up											
MACADAM	General											
	Rolling Stone											
	Spreading Stone											
	Total Hours	10	10									
	Rate Per Hour	35	20									

All remarks must appear on the other side

Foreman

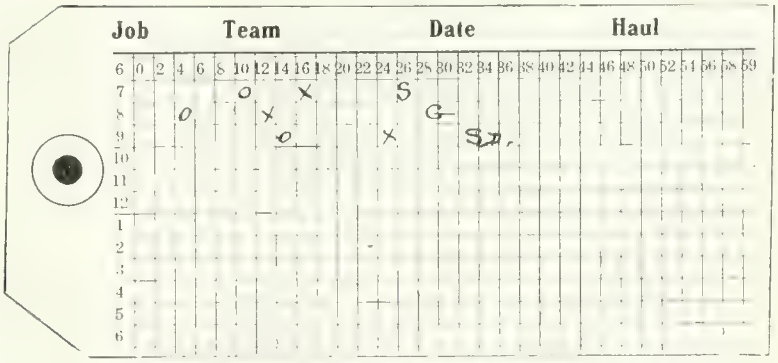
Fig. 2—Blank Used for Daily Time Sheet.

The filler that conforms to all these conditions is a bituminous filler, and the one that most engineers find satisfactory is a straight run coal tar pitch having a melting point varying not more than 5 degrees either way from 135 degrees. Coal tar pitch is not only the most satisfactory, but is the cheapest. It adheres perfectly to brick, stone or concrete (curb or gutter) even when applied under unfavorable weather conditions, and bonds the bricks firmly together. Any possible break or joint is only temporary, as on the first warm day the pitch filler closes up as tightly as before. The safe footing is provided for horses, there are no cracks in the pavement and no rumbling hollow sounds because of sections raising from the foundation.

Pitch filler also permits of immediate use of pavement instead of being blocked up for eight to fifteen days, as in the case of grout filler. In the higher melting points made so much of in the so-called oil asphalt fillers, lies their greatest weakness. To obtain these melting points the oil asphalt is distilled so far that it loses practically all its strength and in a short time becomes "dead" and crumbly; it therefore will not bind the bricks or blocks firmly together except when applied under ideal conditions, which are seldom or never obtained in practice. If there is any moisture in the brick or block, the hot asphalt brings it to the surface and forms a film between the brick itself and the filler, which prevents adhesion. Also, on account of this high melting point, an asphalt filler has to be heated and applied very hot, and as it chills quickly on the bricks it frequently fails to run to the bottom of the joints.

Unless a tight joint is made at the time of application such a filler will never adhere to the brick, as the maximum temperature of the pavement in summer will not reach the point where asphalt becomes sticky. As evidence of this fact, it is a matter of common knowledge among contractors for brick pavements that in removing sections where such a filler has been used the filler can be thrown into one pile and the bricks into another. The nature of some fillers is such that while they compress readily as the bricks expand, when the bricks contract the filler does not settle and expand accordingly. The result is that the filler between the brick is loose and serves no purpose, and as evidence of this would cite cases where horses' calks have pulled out the filler in strips from between the blocks. Such a filler is very little, if any, better than sand.

It is common knowledge that a more sticky material is required to properly adhere to stone or concrete curb than to bricks or blocks, and as most of the moisture develops in the gutters next to the curb, it is particularly necessary where expansion joints only are used, to have a material that will insure a water-tight pavement at this point. Finally, engineers should not be confused regarding the value of special characteristics in this or that bituminous material, but should consider only such material as will serve all the purposes for which it is required and at a minimum cost. Most bituminous fillers are expensive both in material cost and cost of application, while coal tar pitch is readily obtainable the country over at prices averaging less than half those charged for other bituminous materials, and besides the pitch can be applied at a much lower cost.



Job Team Date Haul

6 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 59
7
8
9
10
11
12
1
2
3
4
5
6
O
X
S
G
O
X
O
X
Sp.

Fig. 4—Teaming Card.

Permission has been granted to certain Chinese to establish water works in Peking. The company has a capital of 500,000 taels, and will begin work, it is stated, at once. The water will be brought from the Sha River and Ching River.

The Use of Wood Piles Driven at an Angle in Dock Construction.*

At Bremen and notably at Bremerhaven, it is the practice to construct much of the new work in the dry. The area to be enclosed is stripped, by land dredges and cars, to 3 or 4 ft. below low water, and is kept dry by pumps. Along the proposed line of quay wall, two single rail tracks are laid, about 33 ft. apart; these serve to carry a pile driver which traverses a carriage supported by the two rails. The pile driver is arranged to swivel in two directions; thus the driver can be placed with great precision and dispatch, and piles can be driven at any desired batter. It is the practice to select long piles, and first drive each tenth bent of piles. The ways are marked with a metric scale, and an attendant records the position of the pile at each fifth or tenth blow. From these data piles of suitable length are selected for the intervening nine bents, and a similar record of driving is kept. Should one or more piles in a group settle too much during the last ten blows, a longer pile is driven in the bent or in the adjoining bents to give additional bearing power. The bents, when driven, batter about 1 on 5, like the letter A. At the cross of the A, two strong timbers are bolted to the framed piles, and longitudinal wales are bolted to the piles and side pieces, and a 6-in. wood floor completes the foundation. Upon this foundation a quay wall of rubble-faced concrete is built, and is bonded to the rear piles by tension rods, after which the area is opened and excavated to the full depth by dredges. A construction of this kind resists most effectively the thrust from the landward mass of earth, the outer piles being compressed and the rear piles in tension.

Mr. Claussen, Dock Engineer at Bremerhaven, says that he considers 15 tons per pile a safe load when used in tension. A number of long walls, such as the sides of a dry dock, quay walls, and locks in use for ten years, were remarkably straight, and offered strong evidence as to the value of this system of construction. This could not be used if limnoria or teredo were present, unless the piles in the outer row were covered by a concrete wall; but it might have application for mooring bits, etc., where the piling is protected, and perhaps would be advantageous where it is required to erect a temporary bulkhead and load the ground landward for a year or more, so as to consolidate it before commencing the permanent construction of a quay wall.

---

*Abstracted from a paper in the Proceedings American Society Civil Engineers, Vol. XXXIV, entitled "Notes on Dock and Harbors," by Luther Wagoner. The paper is to be presented before the society on Sept. 2, 1908.

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0743. **Granite Roofing.**—Eastern Granite Roofing Co., New York City.

This 64-page pamphlet illustrates a great variety of buildings on which granite roofing has been used. The roofing itself is described in some detail and hints are given as to the best methods of putting it in place and keeping it in proper repair.

No. 0744. **Foundry Supplies.**—Frederic P. Stevens, Detroit, Mich.

This is an unusually complete catalog of 223 pages. It lists a large line of founders' tools and supplies. Each of the articles listed is illustrated and described in such detail as is necessary to make the merits clear. Tables of dimensions, capacities, price-lists, etc., are also given. The catalog is provided with a well arranged index.

No. 0745. **Leather Packing.** — Detroit Leather Specialty Co., Inc., Detroit, Mich.

This pamphlet presents in a convincing manner the requirements and advantages of leather packing and there are also a large number of testimonial letters from firms which have used these packings. It may be noted that the company does not make up packings and keep them in stock, but manufactures each size and style of packing to the specifications of the purchaser. The argument in favor of this method of supplying packing is well worth reading.

No. 0746. **Sarco Mineral Rubber Pipe Coating.**—Standard Asphalt & Rubber Co., Chicago.

Recent experience with the rusting and pitting of steel water pipe makes the contents of this pamphlet of particular interest to water works engineers. The coating which is described is claimed to be a perfect insulator against electric currents as well as against the ordinary attacks of rust from moisture. The method of applying the coating, the composition and some idea as to the cost are given.

No. 0747. **Cast Iron Specials.**—James B. Clow & Sons, Chicago, Ill.

The company named above is well known for its extensive line of cast iron pipe, hydrants and specials of all kinds for water works engineers. This book of 181 pages illustrates and describes all of these various articles and gives their cost prices. The articles listed include practically everything in the way of valves, hydrants, water works tools, fountains, etc., used by the city water works departments. It is so well arranged and printed and so complete that water works superintendents should make a point of having it on file.

No. 0748. **Hoisting Engines.**—The John F. Byers Machine Co., Ravenna, O.

This company, as most of our readers know, manufacture a very complete line of portable and semi-portable hoisting engines. This pamphlet describes the construction of these machines in some detail, gives weights, dimensions, prices, etc. In addition to hoisting engines the catalog illustrates and describes contractors locomotives, derricks, winches and derrick fittings and supplies. The line of goods shown is very complete and contractors will do well to have a copy of this catalog on file.

No. 0749. **Concrete Machinery.** Dykema Co., Grand Rapids, Mich.

This large pamphlet describes and illustrates a large line of machinery and tools for concrete block, tile and ornament manufacture. The company's dry process block and brick machines are very fully shown, and also its wet process molds. Tile and sewer pipe molds are described and also molds for columns, balusters and other ornamental work.

No. 0750. **The Allis-Chalmers Works and Products.**—Allis-Chalmers Co., Milwaukee, Wis.

This handsome pamphlet gives a descriptive account of the works and products of the company named. Each of the several classes of products is treated separately, and altogether a very good idea is given of the wide range of manufacturing activity of the company's works.

No. 0751. **Concrete Mixers.**—Samson Machine Co., St. Louis, Mo.

This pamphlet describes and illustrates a hand power concrete mixer of 3½ cu. ft. capacity of mixed concrete. The operation of the mixer and its several merits are set forth in an interesting manner.

No. 0752. **Price List of Wire Rope and Wire.**—John A. Roebling's Sons Co., Trenton, N. J.

This is a very handy, little, general catalog and price list of the line of wire rope and wire products of the company named. The several styles of rope are described, hints are given for the handling and care of wire rope, and suspension bridge cable wire and cableways are discussed. Users of wire rope should have this pocket catalog at hand.

Personals.

Havemeyer Construction Co., of Chicago, Ill., has removed to its new offices at 145 La Salle street, that city.

Col. William C. Gorgas, Chief Sanitary Officer of the Isthmian Canal Zone, has been elected President of the American Medical Association.

Mr. Louis W. Spencer has been transferred as an Assistant Engineer from the Bureau of Highways of Queens Borough, New York City, to the Topographical Bureau of that Borough.

Mr. W. J. Rashleigh, Superintendent of the St. James Mine at Aurora, Minn., has been appointed Superintendent of Construction for the sewer system which is to be installed in that city.

Mr. H. P. Parrock, formerly Chief Engineer of the Youngstown Foundry & Machine Co., Youngstown, O., has been appointed Chief Consulting Engineer for William B. Hough Co., Chicago, Ill.

Mr. Geo. W. Arnold, C. E., of Glyndon, Md., on the advice of his physician, has been obliged to discontinue tunnel engineering for several months, during which time he will engage in private engineering practice.

Messrs. James M. Mount, of Montgomery County, Md.; William C. Johnson, of Washington, D. C.; Dr. Thomas B. Johnson, Otho J. Keller and William O. Keller, of Frederick, have organized the Highway Construction Co., of Frederick, Md., and will engage in a general contracting business.

At the last meeting before the summer recess of the Engineers' Club of Philadelphia, on June 6, Mr. H. S. Righter described "The Elevation of the Philadelphia & Washington R. R. Co.'s Tracks Through Wilmington, Del.," and Mr. Myron H. Lewis read a paper on "Water-proofing—An Engineering Problem."

Messrs. Logan Waller Page, Director of the U. S. Office of Public Roads, Clifford Richardson, Proprietor of the New York Testing Laboratories, and Col. Charles G. Bromwell, Corps of Engineers, U. S. Army, have been designated by President Roosevelt as the official delegates of this country to the International Roads Congress at Paris.

Sir Robert Gillespie Reid, railroad builder and capitalist, died June 3. He was a native of Scotland, and went in 1865 to Australia, where he engaged in mining and public works. Six years later he came to America, taking up active work as a railway and bridge builder. One of his first undertakings was the construction of the International bridge across the Niagara River. Mr. Reid's greatest work, from a physical standpoint, was on the Canadian Pacific north of Lake Superior, which included a tunnel 450 feet in length through solid granite. He was also largely interested in Newfoundland coal land developments.

Lieut.-Col. Harry F. Hodges, Corps of Engineers, U. S. Army, and Chief Purchasing Officer of the Isthmian Canal Commission, has been made a member of the Commission, vice Jackson S. Smith, resigned. Col. Hodges will retain his status in the army. Maj. Carroll A. Devol, Quartermaster's Department, who has been on duty in Washington as a member of the general staff, has been appointed head of the Department of Labor, Quarters, Subsistence and Commissary, with headquarters on the isthmus. He will be assisted in his work by Maj. Eugene F. Wilson of the artillery corps. The position of chief purchasing officer made vacant by the appointment of Col. Hodges on the commission will be filled by Capt. Frank C. Boggs, Corps of Engineers, who at present is the Assisting Purchasing Officer.

CONTRACT NEWS

INDEX.

	PAGES
Bids Asked	19
Bridges	20
Buildings	20
Roads and Streets	20
Sewers	21
Water Supply	21
Excavation	21
Miscellaneous	22
Material, Machines, etc	22
Contracts Let	22

We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.	See Issue.
June 10. Buffalo, N. Y.	May 27
June 10. Cleveland, O.	May 27
June 10. Spokane, Wash.	May 27
June 10. Chicago, Ill.	June 3
June 11. Keosauqua, Ia.	June 3
June 11. Hamilton, O.	May 27
June 11. Towson, Md.	June 10
June 11. Kentland, Ind.	June 10
June 12. Pittsburg, Pa.	June 10
June 13. Byron, Mich.	June 10
June 15. St. Clairsville, O.	May 27
June 16. Salina, Kan.	June 10
June 16. Houston, Tex.	June 10
June 17. Jackson, O.	June 10
June 17. Red Wing, Minn.	June 10
June 19. Paulding, O.	June 10
June 19. Lufkin, Tex.	June 10
June 20. Washington, D. C.	June 10
June 20. Chicago, Ill.	June 10
June 22. Youngstown, O.	June 10
June 24. Goshen, Ind.	June 3
June 25. Muskegon, Mich.	June 10
June 26. Mitchell, S. Dak.	June 10
June 26. Cincinnati, O.	June 10
June 27. Findlay, O.	June 10
June 29. Zanesville, O.	June 10
July 1. Cleveland, O.	June 10
July 7. Yreka, Cal.	June 3
July 8. Eureka, Cal.	June 10

Buildings.

June 10. New Castle, Pa.	May 20
June 10. Fort Slocum, N. Y.	May 20
June 10. Ogden, Utah	May 6
June 10. New Castle, Pa.	May 27
June 10. Au Sable Forks, N. Y.	May 27
June 10. Jersey City, N. J.	May 27
June 10. Boswell, Ind.	May 27
June 10. Cairo, Ill.	June 3
June 10. Baltimore, Md.	June 3
June 10. Baltimore, Md.	June 3
June 11. Wampsville, N. Y.	May 27
June 11. Fort Sam Houston, Tex.	May 20
June 11. New York, N. Y.	June 10
June 12. San Luis Obispo, Cal.	May 20
June 12. St. Charles, Mo.	May 6
June 13. Edmonton, Alberta	May 27
June 14. West Point, N. Y.	May 20
June 15. Fort Yellowstone, Wyo.	June 3
June 15. Fort Meade, S. Dak	June 3
June 15. New York, N. Y.	June 10
June 15. New York, N. Y.	June 10
June 15. Topeka, Kan.	June 10
June 16. New York, N. Y.	June 10
June 16. National Soldiers Home, Va.	June 3
June 16. Fort Worth, Tex.	May 20
June 17. Newton, Kan.	May 13
June 17. New York, N. Y.	June 10
June 17. Fort Omaha, Neb.	June 10
June 18. New York, N. Y.	June 10
June 18. Fort Riley, Kan.	June 10
June 18. Houston, Tex.	May 27
June 18. Milwaukee, Wis.	June 3
June 19. Chemawa, Ore.	May 27
June 19. Council Bluffs, Ia.	June 10
June 19. Fort Dade, Fla.	June 10
June 20. Sturgeon, Pa.	May 27
June 22. Provo, Utah	May 20
June 22. Regina, Sask.	June 3
June 23. Spokane, Wash.	May 27
June 22. Albany, N. Y.	June 10
June 24. Albany, N. Y.	June 10
June 24. Fayetteville, Ark.	May 20
June 24. Jefferson Barracks, Mo.	June 3
June 24. Riverside, Cal.	June 3
June 25. Sandy Hook Proving Ground, N. J.	June 3
June 25. Greenville, Tex.	May 20
June 25. Auburn, N. Y.	June 10
June 27. Canandaigua, N. Y.	June 10
June 29. Massillon, O.	June 10
June 29. Fort D. A. Russell, Wyo.	June 10
June 29. Sumter, S. C.	May 27
June 29. Sioux City, Ia.	June 3
June 30. Meadville, Pa.	May 20
July 1. Baltimore, Md.	May 27
July 1. Memphis, Tenn.	June 10
July 2. Columbia, Tenn.	May 27
July 2. Washington, D. C.	June 10
July 3. West Point, N. Y.	June 10
July 6. Marietta, Ga.	May 27
July 7. Iola, Kan.	June 3
July 7. Douglasville, Ga	June 10
July 8. Cheyenne, Wyo.	June 10
July 9. Springfield, O.	June 10
July 14. Sharon, Pa.	June 10
July 15. Valdosta, Ga.	June 10
July 20. Auburn, Me.	June 10

Roads and Streets.

June 10. Indianapolis, Ind.	June 3
June 10. Pittsburg, Pa.	June 3
June 11. Brooklyn, N. Y.	June 3
June 11. Towson, Md.	June 10
June 12. Des Moines, Ia.	June 10
June 12. Olean, N. Y.	June 3
June 13. Milwaukee, Wis.	June 10
June 13. Milwaukee, Wis.	June 10
June 13. Washington, D. C.	June 10
June 15. Clarksdale, Miss.	June 3
June 15. Takoma Park, D. C.	June 3
June 15. Montgomery, Ala.	May 27
June 15. Fort Barrancas, Fla.	May 20
June 15. Herkimer, N. Y.	June 10
June 15. Staples, Minn.	June 10
June 15. Mt. Carmel, Ill.	June 10
June 16. Houston, Tex.	June 10
June 16. Frankfort, Ind.	June 10
June 16. Freehold, N. J.	June 3
June 17. Harrisburg, Pa	May 27
June 17. New York, N. Y.	June 10
June 18. Oak Park, Ill.	June 10
June 18. Chicago, Ill.	June 10
June 18. Harrisburg, Pa.	May 27
June 18. Johnson City, Tenn.	June 3
June 18. Mt. Gilead, O.	June 3
June 19. Bellefonte, Pa.	May 27
June 20. Butler, Pa.	May 27
June 22. Aberdeen, S. Dak.	May 27
June 22. Fort Dade, Fla.	May 27
June 22. Selma, Ala	June 3
June 22. Warren, O.	June 10
June 23. Taylorville, Ill.	June 10
June 23. Toms River, N. J.	June 3
June 24. Lebanon, Pa.	June 3
June 24. Cadiz, O.	June 3
June 24. Madison Barracks, N. Y.	June 10
June 24. Indianapolis, Ind.	June 10
June 26. Cincinnati, O.	June 10
June 26. Cincinnati, O.	June 10
June 29. Harrisburg, Pa.	June 3
June 30. Harrisburg, Pa.	June 3
July 1. Concord, Neb.	June 3
July 1. Fort Barrancas, Fla.	May 27
July 2. Bozeman, Mont.	June 10
July 15. Cleveland, O.	June 10

Sewers.

June 10. Oakland, Cal.	May 20
June 10. Brooklyn, N. Y.	May 27
June 11. Fort Wayne, Ind.	June 3
June 11. Jefferson, Wis.	June 10
June 12. Youngstown, O.	June 10
June 12. Columbus, O.	June 10
June 12. Grafton, N. Dak.	June 10
June 15. Fergus Falls, Minn.	June 10
June 15. Coffeyville, Kan.	June 10
June 15. Melrose Park, Ill.	June 10
June 15. Vinton, Ia.	June 10
June 15. Houston, Tex.	June 10
June 15. Napoleon, O.	June 10
June 15. Elizabeth, N. J.	June 10
June 15. Auburn, Ind.	June 3
June 15. Washington, D. C.	June 3
June 16. Newark, O.	June 10
June 16. Summit, N. J.	June 10
June 16. St. Louis, Mo.	June 10
June 16. Gas City, Ind.	June 10
June 16. East Hartford, Conn.	June 10
June 16. Lake Placid, N. Y.	June 10
June 17. Youngstown, O.	June 10
June 18. Chicago, Ill.	June 10
June 18. Riverton, N. J.	June 3
June 19. Boston, Mass.	June 10
June 20. Oshkosh, Wis.	June 20
June 22. Davenport, Ia	June 3
June 22. East Rutherford, N. J.	June 10
June 22. Shelby, N. C.	June 10
June 25. Newton, Kan.	June 10
June 30. Columbus, Miss.	June 10
July 1. Waterloo, N. Y.	June 10
July 1. Elizabeth, N. J.	June 3

Water Supply.

June 10. Brooklyn, N. Y.	May 27
June 10. Brooklyn, N. Y.	May 27
June 10. Baltimore, Md	May 20
June 12. Springfield, Minn.	June 3
June 13. Milwaukee, Wis.	June 10
June 15. Fort Hamilton, N. Y.	June 3
June 15. Unionville, Conn.	June 3
June 15. Fort St. Philip, La.	May 20
June 16. Wahpeton, N. Dak.	May 27
June 16. Guelph, Ont.	June 3
June 16. Cincinnati, O.	June 3
June 18. Chicago, Ill.	June 10
June 18. Berwyn, Ill.	June 10
June 18. Springfield, Mass.	May 27
June 22. West Allis, Ill.	June 10
June 22. Shelby, N. C.	June 10
June 23. Bruce, Wis.	June 10
June 29. Pittsburg, Pa.	June 10
June 30. Columbia, Miss.	June 10
July 1. Lewisburg, O.	June 3
July 7. Toledo, O.	June 10

Miscellaneous.

June 10. Memphis, Tenn.,	Levee Work,	May 13
June 10. Washington, D. C.,	Launches,	May 20
July 13. Harrisonburg, La.,	Lock and Dam,	May 13
July 15. Sunnyside, Wash.,	Wasteway Channel, Etc.,	May 13
June 15. Jefferson Barracks, Mo.,	Electric System,	June 3
June 15. Fort Mason, Cal.,	Sea Wall,	June 10
June 18. Chicago, Ill.,	Dam, Etc.,	June 10
June 19. Vineyard Haven, Mass.,	Breakwater,	June 10
June 20. Washington, D. C.,	Launches,	June 3
June 23. Columbus, O.,	Dam Construction, Etc.,	June 10
June 26. Chapman, Ky.,	Dam, Walls,	June 3
June 27. Riverton, Ala.,	River Wall,	June 3
July 1. Lewisburg, O.,	Electric System,	June 3
July 1. Boston, Mass.,	Street Lighting,	June 10
July 2. Saltpeter, W. Va.,	Dam, Guide Walls, Etc.,	June 10
July 6. Boston, Mass.,	Piping,	June 10
July 8. St. Andrews, Man.,	Dam, Etc.,	May 27
July 14. Chicago, Ill.,	Wrecking Building,	June 3
July 15. Toronto, Ont.,	Transmission Line,	June 10
June 16. Carrollton, Miss.,	Electric Plant,	May 27
July 17. Los Angeles, Cal.,	Aqueduct,	May 27
Aug. 14. Portland, Ore.,	Light House,	May 27

Excavation, Earth and Rock.

June 10. Fort Dodge, Ia.,	Tile Drain,	May 13
June 10. Fairmont, Minn.,	Ditch Work,	May 20
June 15. Richmond, Va.,	Grading,	June 10
June 15. Memphis, Tenn.,	Grading, Sodding,	June 10
June 16. Memphis, Tenn.,	Levee Work,	May 20
June 23. Harrisburg, Pa.,	Dike,	June 10
June 25. Seattle, Wash.,	Dredging,	June 10
July 1. Crookston, Minn.,	Ditch,	June 10

Materials, Machines, Supplies, Tools, Etc.

June 10. Rome, N. Y.,	Pipe, Specials,	May 27
June 10. New York, N. Y.,	Traveling Cranes,	May 27
June 10. Brooklyn, N. Y.,	Pipe, Tools, Etc.,	May 27
June 10. Madison, Wis.,	Pumps,	June 3
June 11. Chicago, Ill.,	Crushed Stone,	June 3
June 11. New York, N. Y.,	Grills, Castings, Etc.,	June 3
June 11. New York, N. Y.,	Electrical Equipment,	June 3
June 12. Pittsburg, Pa.,	Cement,	June 10
June 13. Chicago, Ill.,	Boilers,	June 10
June 15. Pittsburg, Pa.,	Wagons, Crusher,	June 10
June 15. Washington, D. C.,	Lumber, Rope, Blocks, Etc.,	June 3
June 15. Edmond, Okla.,	Water Works Material,	May 27
June 16. Quincy, Mass.,	Electric Hoists,	Apr. 8
June 16. Chicago, Ill.,	Wire,	June 10
June 17. New York, N. Y.,	Broken Stone, Tar Oil,	June 10
June 17. Brooklyn, N. Y.,	Derricks,	June 10
June 18. New York, N. Y.,	Road Roller,	June 10

June 18.	Washington, D. C.,	Engines, Dynamos, Etc., June 3
June 19.	Minidoka, Idaho,	Electrical Apparatus, May 27
June 20.	Geneva, N. Y.,	Gas Engine, Etc., June 3
June 22.	Washington, D. C.,	Blasting Sets, June 3
June 23.	Chicago, Ill.,	Turbines, Pumps, Etc., June 10
June 24.	Chicago, Ill.,	Electrical Apparatus, June 10
June 24.	Washington, D. C.,	Boiler Room Equipment, June 3
June 25.	Grand Rapids, Mich.,	Pumping Machinery, June 10
June 27.	Washington, D. C.,	Corporation Cocks, June 10
June 30.	New Orleans, La.,	Machinery, Apr. 22
July 1	Memphis, Tenn.,	Fire Alarm System, Clocks, Etc., June 10
July 7.	Houston, Tex.,	Pumping Engine, June 10
July 8.	Atlanta, Ga.,	Boilers, June 3
July 10.	Chicago, Ill.,	Vacuum Cleaning System, June 10

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Eureka, Cal. Until 10 a. m., July 8, by Geo. W. Cousins, County Clerk, for the construction of a steel highway bridge over the South Fork of Eel River at Garberville. The bridge is to consist of one main span 266 ft. long, center to center of end pins, together with 247 ft. of south approach and 38 ft. of north approach. The roadway is to be 16 ft. wide.

Washington, D. C.—Until noon, June 20, by District Commissioners, 43 District Bldg., for supplying and installing electro-magnetic brakes on the Anacostia River Bridge Draw, D. C.

Chicago, Ill.—Until 11 a. m., June 20, by Department Public Works, 326 City Hall, for labor and materials for erection of superstructure for a bascule bridge over north branch of Chicago River at Erie St. Separate bids are also asked for constructing the substructure.

Kentland, Ind.—Until noon, June 11, by A. E. Purkey, County Auditor, for constructing 11 bridges, concrete abutments, etc.

Salina, Kan.—Until June 16, by County Commissioners, for constructing a 90-ft. bridge and a 70-ft. bridge.

Towson, Md.—Until noon, June 11, by Henry G. Shirley, County Roads Engineer, for constructing following: Small reinforced concrete bridge on the Texas road, over branch of Beaver Dam run; reinforced concrete bridge on the South Garrison Forest road, over Jones' falls; reinforced concrete bridge on the Trenton road, over Little Piney run; reinforced concrete bridge on the Thistle road, over Dugan's run; reinforced concrete culvert on the Offutt road, over branch of the Marcella run; reinforced concrete culvert on the Offutt road, over branch of the Marcella run No. 2; reinforced concrete superstructure to bridge on Woodholm Ave., over branch of Gwynn's falls; reinforced concrete superstructure and pier to bridge on the Philadelphia road, over White Marsh run; reinforced concrete culvert on the Middle River road, over small stream near Middle River Station.

Byron, Mich.—Until June 13, by Mr. J. O'Meara, Byron Center, Mich., for construction of a bridge in Byron Township.

Muskegon, Mich.—Until noon, June 25, by County Supervisors, T. B. Crocker, Secretary, for material and labor for constructing a steel draw bridge, 100 ft. long, over Muskegon River at Bank St., Muskegon; a bridge over Mona Lake in Norton Township, 1,000 ft. long, and a 200 ft. steel bridge over the Muskegon River at Maple Island.

Red Wing, Minn.—Until 10 a. m., June 17, by Carl N. Lien, County Auditor, for constructing bridge over Bullard's Creek in town of Hay Creek. Bridge is to consist of steel riveted span 60 ft. long, resting on rubble concrete abutments.

Cincinnati, O.—Until noon, June 26, by County Commissioners, Fred Dreihs, Clerk, for constructing steel superstructure of a highway bridge over Little Miami River on the Montauk Road.

Cleveland, O.—Until 11 a. m., July 1, by County Commissioners, William F. Black, County Auditor, for the construction of bridge work per Report No. 1906, concrete arch, Broadview Road, Parma Township, Engineer's estimate $3,521.

Findlay, O.—Until noon, June 27, by John A. Sutton, County Auditor, for construction of substructure for steel bridge over Blanchard River in Delaware Township. Bids are asked on concrete abutments and piers, or constructed of stone masonry. Certified check for $500 required with bid.

Jackson, O.—Until 1 a. m., June 17, by Ed Monahan, County Surveyor, for seven reinforced concrete bridges, containing 370 cu. yds., and 72 ft. span steel bridge; also stone abutments for steel bridge, containing 130 cu. yds.

Paulding, O.—Until 2 p. m., June 19, by Floyd Atwill, County Auditor, for constructing four steel bridges, eight concrete bridges, 29 concrete culverts, several iron pipe culverts, concrete abutments, retaining walls, etc.

Youngstown, O.—Until 11 a. m., June 22, by County Commissioners, for construction of sub and superstructure of a bridge, filling approaches and grading the hill at Washingtonville. Certified check for $500 required with bid. Will B. Jones, County Auditor.

Zanesville, O.—Until noon, June 29, by L. E. Brelsford, County Auditor, for repairing 450 ft. span suspension bridge over Muskingum River at Dresden, by renewing both trusses and floor system, etc.

Pittsburg, Pa.—Until noon, June 12, by F. P. Booth, County Controller, for sub and superstructures for two through plate girder bridges.

Columbia, S. C.—T. I. Weston, County Engineer, is reported to be asking bids for construction of a highway bridge over Little River.

Mitchell, S. Dak.—Until June 26, by H. B. Anderson, County Auditor, for constructing five bridges as follows: 70 ft. steel bridge on cement abutments in Mitchell Township, 60 ft. steel bridge on cement abutments in Blendon Township, 40 ft. steel bridge on steel legs in Loomis, a truss bridge on cement abutments in Ethan, 16 ft. long pile bridge in Rome township.

Houston, Tex.—Until June 16, by John B. Ashe, County Auditor, for constructing bridge over White Oak Bayou at Brunner; also for bridges on Leeland Ave. road, and for two bridges on Addicks County road.

Lufkin, Tex.—Until June 19, by County Commissioners, for building three iron bridges.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Until 2 p. m., July 2, by Frank Pierce, Acting Secretary of Interior, for erection of an assembly hall at the Government Hospital for the Insane.

Fort Dade, Fla.—Until 8 p. m., June 19, by Constructing Quartermaster, for construction, plumbing and electric wiring lavatory, mess hall, gymnasium and bowling alley; also for construction and electric wiring of a second-story addition to two barracks.

Douglasville, Ga.—Until July 7, by this city, for erection of a $15,000 school building.

Valdosta, Ga.—Until 3 p. m., July 15, by James Knox Taylor, Supervising Architect, Washington, D. C., for construction complete (except elevator) of U. S. post office and court house at Valdosta.

Council Bluffs, Ia.—Until June 19, by Board of Education, J. A. Brice, for erection of a school building.

Fort Riley, Kan.—Until 10 a. m., June 18, by Capt. W. M. Whitman, Constructing Q. M., for construction, plumbing heating, wiring and installation of electric fixtures in one artillery guard house, and alterations of construction, plumbing and wiring in nine artillery stables.

Topeka, Kan.—Until June 15, by Board of Education, J. E. Stewart, Clerk, for erection of a 12-room school building.

Auburn, Me.—Until 3 p. m., July 20, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. post office at Auburn.

Fort Omaha, Neb.—Until June 17, by Capt. W. H. Oury, Constructing Q. M., for construction, plumbing, heating, electric wiring and fixtures of a bakery at this post.

Albany, N. Y.—Until 3 p. m., June 24, by State Commission in Lunacy, T. E. McGarr, Secretary, for hydrotherapeutic and prolonged bath equipment and construction for Utica, Poughkeepsie and Binghamton State Hospitals. Franklin B. Ware, State Architect, Albany.

Albany, N. Y.—Until June 22 (extension of time from June 2), by Robert H. Fuller, Secretary Trustees for Public Buildings, Capitol, for erection of state education building. Bond for $1,000,000 required of successful bidder. Palmer & Hornbostel, Architects, 63 William St., New York City.

Auburn, N. Y.—Until June 25, by Board of Education, for erection of a high and grammar school building.

Canandaigua, N. Y.—Until June 27, by County Commissioners, for improvements to county court house. Work will cost about $120,000.

New York, N. Y.—Until 11 a. m., June 15, by C. B. Snyder, Superintendent of School Buildings, Park Ave. and 59th St., for general construction of additions to Public School 87, Dry Harbor Road, Queens Borough; security required $90,000. Bids are also asked for alterations, repairs, etc., to a number of school buildings.

New York, N. Y.—Until 2:30 p. m., June 15, by Robert W. Hebberd, Commissioner of Charities, foot of E. 26th St., for construction of a staff house, and the extension of two tuberculosis infirmaries, for the Metropolitan Hospital district, Blackwells Island, Borough of Manhattan, the city of New York. Raymond F. Almirall, Architect, 51 Chambers St.

New York, N. Y.—Until 2:30 p. m., June 18, by Robert W. Hebberd, Commissioner of Charities, foot of E. 26th St., for the construction of a hospital pavilion in connection with the Home for the Aged and Infirm, Blackwells Island, New York. Surety required is $15,000. Raymond F. Almirall, Architect, 51 Chambers St.

New York, N. Y.—Until 2:30 p. m., June 11, by Robert W. Hebberd, Commissioner of Charities, foot of E. 26th St., for furnishing all the labor and materials required for the erection and entire completion of a new male dormitory at the New York City Farm Colony, Borough of Richmond. Surety required is $10,000.

New York, N. Y.—Until 2 p. m., June 17, by John F. Ahearn, Borough President, for repairs and alterations to city court house (brown stone building), City Hall Park. Security required is $20,000. Charles I. Berg, Architect, 571 Fifth Ave.

New York, N. Y.—Until 3 p. m., June 16, by John W. Brannon, President Board Trustees, 26th St. and 1st Ave., for labor and materials required for the plumbing and drainage, and other work for the pathological department and male dormitory of the new Bellevue Hospital. Surety required is $20,000.

West Point, N. Y.—Until noon, July 3, by Quartermaster, for erection of a gymnasium, chapel, chaplain's quarters, officers' quarters and battalion guardhouse.

Springfield, O.—Until 3 p. m., July 9, by James Knox Taylor, Supervising Architect, Washington, D. C., for construction complete of extension to U. S. post office at Springfield.

Massillon, O.—Until noon, June 29, by Board Public Service, G. G. Paul, Secretary, for constructing city hall building; three stories, 70x120 ft. J. M. Bostick, Architect, Canton, O.

Sharon, Pa.—Until 3 p. m., July 14, by James Knox Taylor, Supervising Architect, Washington, D. C., for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring) of the U. S. post office at Sharon.

Memphis, Tenn.—Until noon, July 1, by County Court House Commissioners, John Colbert, Secretary, for steel fixtures, steel detention cages, time clock system, fire alarm system, interior marble work and electric and gas light fixtures for new court house. Hale & Rogers, Architects, 11 East 24th St., New York. Bids are also asked for furniture, furnishings, etc.

Cheyenne, Wyo.—Until 3 p. m., July 8, by James Knox Taylor, Supervising Architect, Washington, D. C., for finishing attic and miscellaneous work at U. S. Public Building at Cheyenne.

Fort D. A. Russell, Wyo.—Until 11:30 a. m., June 29, by Capt. V. K. Hart, Constructing Q. M., Cheyenne, Wyo., for furnishing all material and labor required for construction of two pavilion ward wings and corridors to the Post Hospital now being constructed at Fort D. A. Russell, Wyoming, with other items of omitted work; also for heating, plumbing and fixtures and electric wiring and fixtures for the above additional ward wings with plumbing fixtures for main building.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Until noon, June 13, by District Commissioners, Room 43, District Bldg., for grading Massachusetts Ave., N

W., extended; and for filling approaches to the viaduct across the B. & O. R. R. on Monroe St., N. E.

Des Moines, Ia.—Until 11 a. m., June 12, by George F. Poorman, City Clerk, for constructing 2,475 sq. yds. asphalt pavement in Center Drive.

Chicago, Ill.—Until 11 a. m., June 18, by Department Public Works, 225 City Hall, for grading and macadamizing Rogers Ave., from Clayton Court to a point 70 ft. east.

Mt. Carmel, Ill.—Until 2:30 p. m., June 15, by this city for constructing 3,000 ft. of brick pavement on 5th St. Guy W. Courted, City Engineer.

Oak Park, Ill.—Until 9 a. m., June 18, by Board of Local Improvements, B. C. Brandstadt, Secretary, for constructing concrete sidewalks on a number of streets.

Taylorville, Ill.—Until 2 p. m., June 23, by A. T. Kinney, President Board Local Improvements, for 14,341 sq. yds. vitrified brick pavement on 6 in. concrete base and 10,550 lin. ft. concrete curb and gutter. J. W. Dappert, City Engineer.

Frankfort, Ind.—Until 2 p. m., June 16, by Worth Price, City Clerk, for improvement of portions of Oak St. and White St. with combined cement curb and gutter and crushed stone roadway.

Indianapolis, Ind.—Until June 24, by Albert Sahm, County Auditor, for constructing four miles of gravel road.

Towson, Md.—Until noon, June 11, by Henry G. Shirley, County Roads Engineer, for grading, curbing and paving with vitrified brick or block portions of Baltimore St. Alternate bids will be received on tar macadam. Bids are also asked for guttering, grading, curbing and macadamizing section of Roland Ave.; alternate bids will be received on tar macadam.

Staples, Minn.—Until 8 p. m., June 15, by F. W. Findsen, City Clerk, for paving and curbing of 4th St., for two blocks, with brick or creosote wood block paving on concrete base, and sandstone curbing. Oscar Claussen, Consulting Engineer, German Am. Bank Bldg., St. Paul, Minn.

Bozeman, Mont.—Until 7:30 p. m., July 2, by H. H. Holloway, City Clerk, for constructing 25,000 sq. yds. of concrete pavement. Official advertisement will be found elsewhere in this issue.

Herkimer, N. Y.—Until 4 p. m., June 15, by William Wright, Jr., Village Clerk, for constructing 40,000 sq. yds. of pavement.

Madison Barracks (P. O. Sacketts Harbor), N. Y.—Until 2 p. m., June 24, by the Constructing Quartermaster for constructing approximately 86,000 sq. ft. of macadam road; resurfacing 14,500 ft. of road and constructing 32,500 ft. of concrete sidewalks.

New York, N. Y.—Until 11 a. m., June 17, by Lawrence Gresser, President Queens Borough, 5th St. and Jackson Ave., for constructing 4,500 sq. ft. of cement sidewalk.

Cincinnati, O.—Until noon, June 26, by County Commissioners, Fred Dreihs, Clerk, for work under specifications No. 732, improvement of the Jordan Creek road between the bridge at the mouth of the creek and the bridge at Yanney's, in Miami Township.

Cincinnati, O.—Until noon, June 26, by County Commissioners, Fred Dreihs, Clerk, for improvement of Blue Rock pike.

Cleveland, O.—Until 11 a. m., July 15, by William F. Black, County Clerk, for grading and draining of a section of Cannon Road.

Warren, O.—Until June 22, by Board Public Service, Z. F. Craver, Chairman, for constructing asphalt block pavement on Elm St.

Houston, Tex.—Until noon, June 16, by John B. Ashe, County Auditor, for paving 2½ miles of Main St. road, one mile of Crosby and Liberty road, and an additional mile on the Leeland Ave. road.

Milwaukee, Wis.—Until 10:30 a. m., June 13, by Board Public Works, Charles J. Poetsch, Chairman, for constructing brick pavement on concrete foundation on Fond du Lac Ave. Certified check for $4,500 required with bid, and for a similar pavement on Fond du Lac Ave., from 32nd St. to Western Ave., certified check for $2,700 being required with bid for the latter work.

Milwaukee, Wis.—Until 10:30 a. m., June 13, by Board Public Works, Charles J. Poetsch, Chairman, for removing defective sidewalks and replacing them with cement concrete sidewalks in the 17th, 18th, 19th, 20th, 21st, 22nd and 23rd Wards.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

East Hartford, Conn.—Until June 16, by Fire District Commissioners, Edward King, Chairman, for constructing 2,400 ft. of 6-in. pipe sewer and 800 ft. of 10-in. pipe sewer.

Vinton, Ia.—Until 8 p. m., June 15, by W. E. Klingaman, City Clerk, for constructing 2,676 ft. 12-in. and 9,550 ft. of 8-in. pipe sewers.

Chicago, Ill.—Until 10:30 a. m., June 18, by Board Local Improvements, Charles A. V. Standish, Secretary, 203 City Hall, for 15 contracts for constructing tile and brick pipe sewers and contracts for constructing drains.

Melrose Park, Ill.—Until 8 p. m., June 15, by Board Local Improvements, for construction of a main outlet sewer. Plans, etc., with R. E. Williams, Village Engineer, 84 LaSalle St., Chicago, Ill.

Gas City, Ind.—Until June 16, by City Clerk, for constructing trunk sewer and branch. Estimated cost is $15,000.

Coffeyville, Kan.—Until 8 p. m., June 15, by Rosa Bell, City Clerk, for material and labor for constructing sanitary sewer in Sanitary Sewer District No. 3, the work including: 11,600 lin. ft. 15-in. sewer pipe laid complete; 5,800 lin. ft. 12-in. sewer pipe laid complete, including 2 "Y" junctions; 11,900 lin. ft. 10-in. sewer pipe laid complete, including 250 "Y" junctions; 41,500 lin. ft. 8-in. sewer pipe laid complete, including 1,600 "Y" junctions; 110 manholes, complete; 66 flush tanks, complete; 3,500 cu. yds. solid rock (approximately).

Newton, Kan.—Until 7:30 p. m., June 25, by Adella Martin, City Clerk, for constructing lateral sewers, main sewers and purification tank in Sewer District No. 1.

Boston, Mass.—Until 2:30 p. m., June 19, by Metropolitan Water and Sewerage Board, 1 Ashburton Pl., for constructing in earth trench a 42-in. concrete sewer and 12-in. pipe sewers near Section 86 of the extension of the high level sewer, South Metropolitan System, in Washington St., Brighton. Some particulars are estimated to be as follows: Length of 42-in. concrete sewer, 710 ft.; length of 12-in. pipe sewers, 1,640 ft.; 60 cu. yds. of Portland brick masonry; 550 cu. yds. of concrete masonry in trench. The inverts of the sewers are from 9 ft. to 20 ft. below the street surfaces.

Fergus Falls, Minn.—Until 8 p. m., June 15, by G. H. Gard, City Clerk, for constructing sewer in Broadway, the work including 1,075 cu. yds. excavation, 864 lin. ft. 8-in. sewer pipe 168 lin. ft. 6-in. sewer pipe, 21 house connections, 2 manholes and 4 catch basins.

Columbia, Miss.—Until 3 p. m., June 30, by Mayor and Board of Aldermen, for construction of complete sewer system and water works. Xavier A. Kramer, Engineer, Magnolia, Miss.

St. Louis, Mo.—Until noon, June 16, by Board Public Works, W. B. Dryden, Secretary, for the "emergency work" required for the maintenance of sewers, sewer inlets, manholes and appurtenances and the work of making necessary repairs requiring prompt attention of sewers, sewer inlets, manholes and appurtenances wherever and whenever directed by the Sewer Commissioner of the City of St. Louis, from July 1, 1908, to July 1, 1909.

Shelby, N. C.—Until June 22, according to reports, by J. F. Tiddy, City Clerk, for constructing sewer system.

Grafton, N. Dak.—Until 7 p. m., June 12, by J. H. Johnson, City Auditor, for material and labor for constructing 757 ft. of pipe sewer.

East Rutherford, N. J.—Until 8 p. m., June 22, by Chas. B. Johnson, Borough Clerk, for constructing sewer system and sewage disposal plants. Work includes 14½ miles of 8-in. to 24-in. sewers and two disposal plants. Wise & Watson, Engineers, Rutherford, N. J.

Elizabeth, N. J.—Until 8 p. m., June 15, by N. K. Thompson, Street Commissioner, for constructing 1,080 lin. ft. of 10-in. sewer pipe.

Summit, N. J.—Until 8 p. m., June 16, by J. Edw. Rowe, City Clerk, for constructing concrete sewer, the work including 4,600 cu. yds. of earth excavation 8 ft. deep, 900 cu. yds. of earth excavation 8 to 14 ft. deep, 250 yds. of earth excavation 14 to 20 ft. deep, 50 cu. yds. of rock excavation, 3,265 lin. ft. of concrete sewer pipe of either parmley block or lock joint concrete pipe. William S. Logan, City Engineer.

Lake Placid, N. Y.—Until 1 p. m., June 16, by the village, for material and laying of 2½ miles of 6-in. to 10-in. pipe sewers. C. E. Collins, Engineer, Drexel Bldg., Philadelphia, Pa.

Waterloo, N. Y.—Until noon, July 1, by John Kropf, Village President, for materials and constructing sewer system and sewage disposal plant for this village. The work will cover about 14 miles of 6-in. to 20-in. vitrified pipe sewer, river crossing and septic tank. Morrison & Farrington, Engineers, Syracuse, N. Y. Official advertisement will be found elsewhere in this issue.

Columbus, O.—Until noon, June 12, by Board Public Service, E. W. Hirsch, Secretary, for constructing relief sewer in Poplar Ave. Certified check for $500 required with bid.

Napoleon, O.—Until June 15, by G. E. Rafferty, Village Clerk, for constructing storm water and sanitary sewer in Union St.

Newark, O.—Until noon, June 16, by Board Public Service, Albert C. Gundlach, Clerk, for constructing tile sewer in Clinton St.

Youngstown, O.—Until noon, June 12, by Board Public Service, W. H. McMillin, Clerk, for labor and materials for improvement of Broadway sewer outlet; certified check for $300 required with bid. Bids are also asked for sewering Cassino Ave., certified check for $200 being required with bid.

Youngstown, O.—Until noon, June 17, by Board Public Service, Wm. H. Mahoney, Clerk, for constructing storm water sewer in Main St.; also for storm water sewer in Kenton St.

Houston, Tex.—Until 3 p. m., June 15, by City Secretary, for installation of sewage lift on Berry St. Certified check for $250 required with bid. H. B. Rice, Mayor.

Jefferson, Wis.—Until 3 p. m., June 11, by Board Public Works, W. S. Henry, Chairman, for construction of sewers, the work including 6,200 lin. ft. 8-in., 335 ft. 10-in., 930 ft. 12-in., 1,378 ft. 15-in., 700 ft. 18-in., and 1,565 ft. 24-in. pipe sewers.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Berwyn, Ill.—Until 8 p. m., June 18, by Board Local Improvements, John F. Coykendall, Secretary, for labor and material for constructing 40,573 ft. 6-in., 6,712 ft. 12-in., 6,843 ft. 10-in., and 1,355 ft. of 12-in. cast iron water main.

Chicago, Ill.—Until 10:30 a. m., June 18, by Board Local Improvements, Charles A. V. Standish, Secretary, 203 City Hall, for 25 contracts for constructing water service pipes.

Columbia, Miss.—Until 3 p. m., June 30, by Mayor and Board of Aldermen, for material and construction of complete water works and sewer systems. Xavier A. Kramer, Engineer, Magnolia, Miss.

Shelby, N. C.—Until June 22, according to reports, by J. F. Tiddy, City Clerk, for constructing water works.

Toledo, O.—Until noon, July 7, by Board Public Service, Reynold Voit, Secretary, for constructing a concrete intake pier, 55 ft. by 26 ft., at the base and 43 ft. in height, including the necessary dredging, etc. The pier is 20 ft. of water and will contain 925 cu. yds. of concrete. Bids are also asked for furnishing and laying of approximately 780 ft. of 48-in. submerged intake pipe, including necessary dredging, back filling, etc., and for brick gate house, 12 by 30 ft., on top of intake pier.

Pittsburg, Pa.—Until 10 a. m., June 29, by Bureau of Filtration, Morris Knowles, Engineer, for construction of filters, pipe gallery, conduits, piping and fixtures, for extension of city filtration work. The work includes 230,000 cu. yds. excavation, 230,000 cu. yds. embankment and fill, 33,500 cu. yds. concrete, 145 tons of steel pipe and 130 tons of cast iron pipe and specials. Official advertisement will be found elsewhere in this issue.

Bruce, Wis.—Until 8 p. m., June 23, by this village, for complete water works and electric light plant installation. Certified check for $500 for entire work or $200 for each portion required with bid. Oscar Claussen, Consulting Engineer, 514 German Am. Bank Bldg., St. Paul, Minn.

Milwaukee, Wis.—Until 10:30 a. m., June 13, by Board Public Works, Charles J. Poetsch, Chairman, for remodeling North Point pumping station. Certified check for $600 required with bid.

West Allis, Wis.—Until noon, June 22, by Board Public Works, F. P. Phillips, Jr., Chairman, for furnishing and laying water mains in portions of 13 streets.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Crookston, Minn.—Ditch.—Until July 1, by N. A. Hoffard, County Auditor, for constructing county ditch No. 72.

Harrisburg, Pa.—Dike.—Until 1 p. m., June 23, by State Water Supply Commission, Thomas J. Lynch, Secretary, for constructing a dike and protecting bank of Delaware

River for a distance of about 2,200 ft. in Matamoras Borough.

Memphis, Tenn.—Grading, Sodding.—Until 5 p. m., June 15, by Board of Education, A. B. Hill, Secretary, for grading, graveling and sodding lots around Dr. R. B. Maury and W. S. Bruce schools. Certified check for $250 required with bid. B. C. Alsup & Co., Architects.

Richmond, Va.—Grading.—Until noon, June 15, by Geo. B. Davis, Superintendent, Room 5, City Hall, for grading the land in front of the new Colored Home.

Seattle, Wash.—Dredging.—Until noon, June 25, by Maj. H. M. Chittenden, U. S. Engrs., for dredging Pend Oreille River, Wash.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Fort Mason, Cal.—Sea Wall.—Until June 15, by Geo. McK. Williamson, Constructing Q. M., Fort Mason, San Francisco, for constructing sea wall and repairing roadway at Fort Winfield Scott.

Chicago, Ill.—Dam, Etc.—Until 11 a. m., June 18, by Department Public Works, 225 City Hall, for building dam and pumping out clay hole at Campbell Ave. and George St.

Boston, Mass.—Piping.—Until 2:30 p. m., July 6, by Charles River Basin Commissioners, William S. Youngman, Secretary, 367 Boylston St., for furnishing and installing piping at the lock in the Charles River Dam.

Boston, Mass. — Street Lighting.—Until noon, July 1, by Guy C. Emerson, Superintendent of Streets, 47 City Hall, for lighting with gas and naphtha incandescent mantle burners on such streets, parks and alleys as may from time to time be designated by the Superintendent for five years from Aug. 1, 1908. The present number of gas lamps is about 10,500 and the number of naphtha lamps about 1,400.

Vineyard Haven, Mass.—Breakwater.—Until 2 p. m., June 19, by Harbor and Land Commissioners, Frank W. Hodgdon, Chief Engineer, State House, for furnishing and placing in position of from 7,000 to 8,000 tons of granite quarry grout to build an extension to the breakwater in Vineyard Haven Harbor, Martha's Vineyard.

Manistique, Mich.—Revetment Work, Etc. —Until 2 p. m., June 22, by Major W. V. Judson, Corps of Engineers, Milwaukee, Wis., for building plank crib revetment, removing old pier, and dredging at Manistique Harbor.

Columbus, O.—Dam Construction, Etc.—Until noon, June 23, by Chas. E. Perkins, Chief Engineer Public Works of Ohio, for improvements on the Miami and Erie Canal and the Ohio Canal, the cost of the work being estimated at $261,000. The work will include rebuilding of dams, locks, and repairing and extension work.

Portsmouth, O.—Flood Defense Wall.—Until noon, June 23, by Board Public Service, Martin W. McMahon, Clerk, for constructing a retaining wall, approximately 4,100 ft. in length, of stone, concrete or reinforced concrete together with the necessary wing walls connecting walls and terminal walls.

Saltpeter, W. Va.—Dam, Guide Walls, Etc. —Until 2 p. m., July 2, by Lt. Col. J. G. Warren, U. S. Engrs., 415 Custom House, Cincinnati, O., for constructing dam, guidewalls, dwelling, etc., at Lock No. 1, Tug Fork of Big Sandy River, at Saltpeter.

Toronto, Ont.—Transmission Line.—Until July 15 (extension of time) by Hydro-Electric Power Commission, Continental Life Bldg., Toronto, for the construction of (a) steel transmission towers; (b) transmission line cable; (c) erection, complete, of transmission system.

Materials, Machines, Supplies, Tools, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Houston, Tex.—Pumping Engine.—Until 3 p. m., July 7, by City Secretary, for furnishing and installing pumping engine of 15,000,000 gallons capacity for 24 hours. H. B. Rice, Mayor.

Washington, D. C.—Corporation Cocks.—Until noon, June 27, by District Commissioners, 43 District Bldg., for furnishing curb and corporation cocks.

Chicago, Ill.—Boilers.—Until 11 a. m., June 13, by Department Public Works, 325 City Hall, for construction and erection in 95th St. sewage pumping station three return tubular boilers. Bids are also asked for three water tube boilers.

Chicago, Ill.—Wire.—Until 11 a. m., June 16, by William Carroll, City Electrician, 12 City Hall, for furnishing 125 miles of No. 6 B. & S. G., H. D., T. B. weatherproof, copper, line wire; 100 miles of No. 6 B. & S. G., H. D. base copper line wire, and 100 miles of No. 10 B. & S. G., H. D. base copper line wire.

Chicago, Ill.—Electrical Apparatus.—Until June 24, by U. S. Reclamation Service, Federal Bldg., Chicago, for furnishing electrical apparatus for power and pumping purposes in connection with irrigation on the Minidoka Project, Idaho. The purchase ultimately contemplated under this advertisement for the power plant will consist of five 1,200 kw. alternating current generators developing current at 2,300 volts, together with the necessary equipment for raising this current to a voltage of 33,000 for transmission to the pumping stations. The ultimate purchase for the pumping stations will consist of eight 600 HP. synchronous motors designed to receive current at a voltage of 2,200 volts and one 360 HP. synchronous motor, operating under the same voltage, together with all necessary transformers, blowers, exciters and other appurtenances.

Chicago, Ill.—Vacuum Cleaning System.—Until 3 p. m., July 10, by James Knox Taylor, Supervising Architect, Washington, D. C., for installation of a vacuum cleaning system for the U. S. Post Office, Court House, etc., building at Chicago, Ill.

Chicago, Ill.—Turbines, Pumps, Etc.—Until June 23, by U. S. Reclamation Service, Federal Bldg., Chicago, for furnishing water turbines, centrifugal pumps and accessories for the pumping of irrigation water on the Minidoka Project, Idaho. The advertisement contemplates the ultimate purchase of five single-runner vertical turbines of 1,800 HP. capacity and two exciter wheels having a capacity of 180 HP., all of which are equipped with governors and other appurtenances relating to the control of the flow of water through the penstocks, and nine large centrifugal pumps of the vertical type, eight of which have a discharge capacity of 125 cu. ft. per second under a total head of 31 ft. and the remaining one of which has a capacity of 75 cu. ft. per second under the same head.

Grand Rapids, Mich.—Pumping Machinery. —Until 8 p. m., June 25, by Board Public Works, Samuel A. Freshney, Secretary, for construction, delivery and erection at water works pumping station of one vertical triple expansion pumping engine of 12,000,000 gallons capacity per 24 hours.

Brooklyn, N. Y.—Derricks.—Until 11 a. m., June 17, by Bird S. Coler, Borough President, for furnishing and delivering six steel frame traveling derricks with vertical gasoline hoisting engines.

New York, N. Y.—Broken Stone, Tar Oil.—Until 11 a. m., June 17, by Lawrence Gresser, President Queens Borough, 5th St. and Jackson Ave., Long Island City, for furnishing and delivering 50,000 gallons of tar oil, and 1,400 cu. yds. of broken stone of limestone, ¾ in.; 300 cu. yds. of limestone screenings; 700 cu. yds. of broken stone of limestone, 1½ ins.; 6,125 cu. yds. of trap rock screenings; 6,575 cu. yds. of broken stone of trap rock, 1½ ins.; 2,400 cu. yds. of broken stone of trap rock, ¾ in.

New York, N. Y.—Road Roller.—Until 3 p. m., June 18, by Park Board, Arsenal Bldg., 5th Ave. and 64th St., for furnishing and delivering a 12-ton three-wheel steam road roller.

Pittsburg, Pa.—Wagons, Crusher.—Until 10 a. m., June 15, by Department Public Works, A. B. Shepherd, Director, for dump wagons and stone crusher.

Pittsburg, Pa.—Cement.—Until 2 p. m., June 12, by F. P. Booth, County Controller, for furnishing about 2,000 bbls. of Portland cement for county work during ensuing year.

Lancaster, S. C.—Water Works Materials. —Until June 24, by Commissioners Public Works, Jno. Crawford, Clerk, for furnishing materials for constructing water works, the materials including 346 tons, 6-in. and 8-in. cast iron pipe, 36 fire hydrants, horizontal duplex pumping engines, horizontal tubular boilers, electrically driven turbine pumps, and the furnishing and erecting of a steel tower and tank. Jaudon & Goss, Engineers, Savannah, Ga.

Memphis, Tenn. — Fire Alarm System, Clocks, Etc.—Until noon, July 1, by County Court House Commission, John Colbert, Secretary, for electric time clock system, and for fire alarm system, etc., for new court house. Hale & Rogers, Architects, 11 East 24th St., New York.

CONTRACTS LET.

The following contracts have been let recently:

Florence, Ala.—Sewers.—Sullivan & Long, Bessemer, Ala., at $2,250, for constructing sewer in Hawthorne Heights.

Los Angeles, Cal.—Street Improvements.—C. W. Brashear has contract for constructing 21,000 sq. yds. of oiled roads at Norwood Terrace for the Briggs Co. He also has contract for constructing 10,000 sq. yds. of oiled roads for same company at tract of lands in Normandie Ave. and 4th St.

Los Angeles, Cal.—Bridge.—Robert Beyrle has contract at $78,400 for constructing concrete bridge over the Los Angeles River at 7th St. Contract was let sometime ago, but agreement between city and railway company as to the division of cost was reached only recently.

Sacramento, Cal.—Macadam Road.—Clark & Henery, at $13,989, for constructing macadam road for county.

Jacksonville, Fla. — Warehouse. — J. G. Christopher Co. has let additional contract to Turner Construction Co., 11 Broadway, New York, for a construction of a reinforced warehouse, three stories and basement, 157½ ft. x 110 ft.

Joliet, Ill.—Water Main.—William Moran, at $3,378, for constructing water main in Franklin and Ohio Sts.

Monmouth, Ill.—Sewer.—A. W. Gates, at $1,948, for constructing two sewers.

Bloomington, Ind.—Sewerage.—W. H. Harris, Terre Haute, Ind., at $101,019, for constructing 11 miles of sewer and sewage purification plant for this city.

Indianapolis, Ind.—Sewer.—Julius Keller Construction Co., at $2.93 per lin. ft., for constructing 31,475 ft. of main sewer in Morris St.

Lafayette, Ind.—Street Improvements.—William E. Frey, for improvement 18th and other streets; Wm. F. Jackson, for improvement of 15th St.

Liberty, Ind.—Bridge.—National Concrete Co., Indianapolis, Ind., at $2,637, for concrete arch over Silver Creek, near Dunlapsville, for the county.

Logansport, Ind.—Bridges.—Samuel Cotner, for constructing several concrete abutments for county bridges.

Terre Haute, Ind.—Gravel Roads.—Malady C. Lloyd, at $2,645, for constructing Kennett Road in Honey Creek Township; Reel & Trueblood, at $7,987, for the Terre Haute and Carlisle Road.

Winchester, Ind.—Bridges, Culverts.—Indiana Bridge Co., Muncie, Ind., at $8,700, for constructing 15 bridges and culverts for the county.

Moorhead, Minn.—Sewer, Watermain, Etc. —James Kennedy, Fargo, N. Dak., at $22,367, for constructing sewer, at $5,198 for water main and at $1,250 for paving and replanking bridge approach.

Benton Harbor, Mich.—Bridge.—W. H. Roney, Monadnock Block, Chicago, Ill., according to reports, at about $61,500 for constructing joint bridge for this city and St. Joseph. The complete structure will be about 312 ft. long, consisting of one swing span 200 ft. long and two equal approach spans; have a roadway 32 ft. wide, and two sidewalks, each 7 ft. wide, and substructure to support same. The approximate quantities of material required are as follows: Piles, 40 to 60 ft. long, 23,000 lin. ft.; sheet piling, 32 ft. long, 160,000 ft. b. m.; common timber, 18,000 ft. b. m.; drift bolts, spikes, etc., 8,000 lbs.; concrete, 1,800 cu. yds.; structural metal, 250 tons; creosoted timber, 54,000 ft. b. m.; creosoted wooden block pavement, 1,100 sq. yds.; electric motors, 2 25-h. p., 50-h. p.

Detroit, Mich.—Sewers.—Langley & Jeynes, at $27,476, for constructing Waterman Ave. sewer, Sec. 3; and at $11,800 for constructing sewer in Fort St.

Iron Mountain, Mich.—Sewer.—J. R. Holfetz, Iron Mountain, at $13,800, for constructing 2,866 ft. of sewers.

Gulfport, Miss.—Paving, Sewers.—Graves-Matthews Shale Brick Co., Birmingham, Ala., at $122,536, for constructing 45,000 sq. yds. of brick pavement and grout filler; J. W. Gurley & Co., Mobile, Ala., at $15,837, for constructing storm sewers.

Missoula, Mont.—Court House.—William Oliver Bridge Co., Spokane, Wash., at $165,230, for constructing county court house.

Baltimore, Md.—Bulkhead.—South Baltimore Construction Co., at $4,028, for constructing stone and timber bulkhead at Center Pier, Back Basin, for city.

Roswell, N. Mex.—Trenching, Etc.—W. C. Glenn and Ab. Rich, Joplin, Mo., at $53,000, for excavation and construction of nine miles of sewers and 27 miles of water mains; city furnishes the material.

Oswego, N. Y.—Bridge.—S. W. Bowles Construction Co., New York, according to reports, at $54,750, for constructing bridge at Utica St., for city. Subcontract for masonry work was let to John Henrick, Oswego.

Syracuse, N. Y.—Water Pipe.—U. S. Cast Iron Pipe & Foundry Co., at $462,935, for furnishing pipe for new conduit line to Skaneateles Lake. Successful bid was as follows: Sec. 1, 1,760 tons 42-in., 2,660 tons 30-in., 2 tons 10-in., and 36,000 lbs. specials, at $24.40 per ton for pipe, and 2½ cts. per lb. for castings. Sec. 2, 4,765 tons 30-in., 1 ton 8-in., and 18,000 lbs. special castings, at $23.40 per ton and 2½ cts. per lb. for castings. Sec. 3, 4,100 tons 30-in., 2 tons 10-in., 1 ton 6-in. straight pipe, 57 tons 30-in. curved pipe, and 26,000 lbs. special castings, at $23.80 per ton for straight pipe, $60 per ton for curved pipe, and 2½ cts. per lb. for castings. Sec. 4, 6,040 tons 30-in., 1 ton 6-in., and 60,000 lbs. special castings, at $23 per ton for pipe, and 2½ cts. per lb. for castings.

Rome, N. Y.—Paving.—Warren Bros. Co., at $53,040, for constructing bitulithic pavement for city.

Cincinnati, O.—Paving, Sewer.—Quill & Poos, at $17,532, for improvement of Grace Ave.; J. E. Mahoney, at $2,093, for sewer in Fairview Ave.

Columbus Barracks, O.—Disinfecting Plant.—Henry F. Romaine, Jr., Columbus, O., at $2,424, for building and $2,299 for apparatus and electrical work for disinfecting plant at Columbus Barracks.

Columbus, O.—Cement Walks.—Indianola Cement Paving Co., Columbus, Henry F. Romaine, Jr., Manager, at $3,200, for constructing cement walks at Ohio State Fair Grounds, for State Board of Agriculture.

New Lexington, O.—School House.—Showers & May, Crooksville, O., at $30,000, for erecting high school for this city.

Wakeman, O.—Following bids were ceievd June 4 on the reinforced concrete arch bridge over the Vermillion River at Wakeman, O., for Huron County: (1) Michael Callan & A. C. Schultz, $19,426. (2) Louis P. Battefeld, Bucyrus, O., $20,800. (3) Masters and Mullen Construction Co., Cleveland, $16,722. (4) C. S. Lambie & Co., Pittsburg, $15,284. (5) Watson & Son, Minerva, O., $16,012. (6) Schillinger Bros. & Co., Columbus (contract awarded), $15,055. (7) Capital Construction Co., Columbus, O. (on alternate plan), $17,671. (8) Home Engineering Co., Canton, O., $18,034; Home Engineering Co. (alternate plan for concrete bridge), $18,865; Home Engineering Co. (alternate plan for steel bridge), $14,784. (9) Modern Construction Co., Fremont, O. (for six alternate plans on steel bridges), $14,782 to $17,870. (10) Hunkins Bros. Construction Co., Cleveland, $18,440. All bids unless otherwise designated are based on engineer's estimate of quantities and on engineer's plans. The bridge is a three-hinged, open spandrels, ribbed arch of 145 ft. span and 220 ft. over all and carries an 18 ft. roadway with reinforced concrete floor. Wilbur J. Watson, Engineer, Cleveland, O.

Steubenville, O.—Sidewalk, Sewers.—Sam Capita, at $1,109, for cement sidewalk, and $1,289 for three sewers.

Reading, Pa.—Paving.—Cunningham & Wherty, Mahoney City, Pa., at $2.06 per sq. yd. for paving Center St. with Porter block.

Knoxville, Tenn.—Sewers.—Long & Price, for sanitary sewers in Broadway and Asylum Ave.; J. A. Ahler Plumbing Co., for sewer in Oak Ave.

Cameron, Tex.—Bridge.—C. O. Horton, Austin, Tex., for bridge over Elk Creek at Waco Crossing for the county.

Houston, Tex.—Bridges.—Roanoke Bridge & Iron Co., Roanoke, Va., at about $40,000, for constructing several railway bridges in Texas.

Salt Lake City, Utah.—Bridge.—William Doyle, Ogden, at $4,742, for constructing concrete bridge at mouth of Ogden Canyon.

Salt Lake City, Utah.—Sewers.—Davis & Heuser, at $1.66 per lin. ft., for constructing 1,477 ft. of sewer in Sewer Extension No. 170; James Kennedy, at $1.28 per lin. ft., for 4,104 ft. of sewer in Sewer Extension No. 192, and $1.31 per lin. ft. for 4,780 ft. of sewer in Sewer Extension No. 194.

Rapidan, Va.—Bridge.—Canton Bridge Co., Canton, O., at $7,366, for erection of steel bridge with stone piers over Rapidan River for county.

Everett, Wash.—Bridge.—C. G. Seely, Denver, Colo., at $7,887, for erecting steel wagon bridge over Skykomish River at Sultan for county. Bridge is to be Baltimore truss, 240 ft. span, with concrete piers and pile trestle approaches.

Prince Rupert, B. C.—Railroad Work.—Advices from this city state that Foley, Welch & Stewart, who have the contract for building several sections of the Grand Trunk Pacific Ry., have awarded subcontracts to Neil Keith, Winnipeg, Man., MacDonald & MacAlister, M. Shady, Smith Bros., Kenora, and Stein Harstone. Contract for clearing right of way on Copper River end of Kitimaat Branch is stated to have been let to Craig Bros., at present engaged on clearing work at Prince Rupert.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States.

San Diego, Cal.—Plans and specifications have been completed for a 360 ft. bridge over the San Diego River and bids for the work will be asked shortly.

Bridgeport, Conn.—Agreement is reported to have been reached between N. Y., N. H. & H. R. R. and city officials whereby the latter will start construction work before next fall on the new bridge over the Pequonnock River at Congress St. A $350,000 bond issue has been provided for this and other work. M. F. McKenna is City Engineer.

New Haven, Conn.—City Council has been petitioned to erect a new bridge over West River at Edgewood Ave.

St. Augustine, Fla.—City Clerk is reported to be calling for bids for constructing concrete bridge over Maria Sanchez Creek at South St.

Mason City, Ia.—A concrete bridge will probably be built over Willow Creek by this city.

Aurora, Ill.—Council has adopted plans of Tibbets & O'Hagen, Bridge Engineers, for the new Fox St. bridges. Plans provide for reinforced concrete arched structures with three spans in each bridge 60 ft. wide, and a roadway of 40 ft. The walks are 10 ft. in width. The cost of the new bridges and removing the present steel structure now in service will come to approximately $66,000.

Danville, Ill.—Resolution is before City Council providing for construction of bridges over Stony Creek at Harrison and Cleveland Sts., at a cost of $4,000.

Maywood, Ill.—Village Board has decided to build a new bridge over the Desplaines River at Lake St.

Belleville, Ill.—County Commissioners have decided to reconstruct wagon bridge over Okaw River at New Athens, which was damaged by recent floods.

Fort Wayne, Ind.—Ordinance is before Council favoring the construction of two new bridges in the city, one between the Lakeside bridge and the State St. bridge and another between the Lakeside bridge and the Walton Ave. bridge.

Vincennes, Ind.—Commissioners of Knox and Daviess Counties have been asked to erect a joint bridge over White River near Edwardsport. According to estimates of County Surveyor J. S. Spiker, the bridge can be built for $16,000.

Meridian, Miss.—W. G. Wetmore, City Engineer, has plans under way for a reinforced concrete bridge at 8th St.

Bernidji, Minn.—City is to erect a steel bridge over the Mississippi River. Bridge, according to plans of City Engineer Stoner, will consist of three spans of 46½ ft. each, with concrete floors, and will cost about $6,500.

Springfield, Mo.—City Engineer Horton has completed plans for bridges to be erected over the Jordan at Boonville St. and Main St.

Dolgeville, N. Y.—Special election may be held to vote on the construction of a bridge over East Canada Creek at Van Buren St. The bridge will cost about $20,000.

Cincinnati, O.—Ordinance is before Council providing for issuing of $25,000 of bonds for building 8th St. bridge.

Springfield, O.—Osborne Engineering Co., Cleveland, O., is preparing plans for proposed $40,000 bridge to be erected over Buck Creek at Nelson St. by the Board of Public Service of this city.

Cleveland, O.—Erie R. R., J. Burke, Engineer M. of W., Cleveland, has notified city that it will replace its old swing bridge near the Central blast furnace with a modern structure of the rolling lift type. Estimated cost is $100,000.

Portland, Ore.—City Engineer Taylor has prepared plans for proposed bridge to replace the old Madison St. structure.

Dallas, Tex.—According to press reports Dallas County will have to expend $100,000 to replace the county's bridges which have been washed out by the recent Trinity River flood.

Wheeling, W. Va.—Special meeting of Council may be called to take steps for securing preliminary plans for Market St. Creek bridge.

Railroads

Items Arranged Alphabetically by States.

Theba, Ariz.—Surveys have been made and capital is being secured for the line which the Ajo Valley R. R. proposes to build a line from Theba, where connection is to be made with the Southern Pacific, south to the Ajo mines, and thence to the Mexican border, about 125 miles.

Washington, D. C.—Washington & Western R. R. Co. has been granted an extension of 18 months in which to complete its line from Georgetown, some 4½ miles to Kensington, where a connection will be made with Baltimore & Ohio R. R.

Louisville, Ga.—The Cotton Belt Ry., recently organized, proposes to the construction of a railroad from Louisville, northeast via Vidette and Wainsboro, to a point near Shell Bluff Landing on the Savannah River, about 50 miles. Frank R. Durden, of the Durden Pine Co., Savannah, is president.

Twin Falls, Idaho.—Idaho & Nevada R. R. Co., which proposes to build a railroad from Twin Falls to Wells, Nev., has filed its articles of incorporation. Surveys for the road were completed sometime ago and its grading work was to be started early in June. The road is to be 114 miles long, and has its principle offices in Boise. H. L. Hollister, Chicago, Ill., is President; R. M. McCollum, Twin Falls, is Secretary.

Chicago, Ill.—J. P. Goodrich, Receiver of the Chicago, Cincinnati & Louisville R. R., has requested authority to issue $1,500,000 of certificates to provide for repairs, equipment, new terminals and to pay labor claims. R. P. Dalton, 355 Dearborn St., Chicago, Ill., is General Superintendent.

Hibbing, Minn.—Duluth, Missabe & Northern Ry., H. L. Dresser, Chief Engineer, Duluth, Minn., is stated to be planning the construction of a large storage yard just west of this place. About 20 miles of track will be laid, and coal docks, round house and an engine house constructed.

Ludington, Mich.—Grand Rapids & Northwestern R. R., of Ludington, has filed a mortgage for $5,000,000 to secure funds for building its projected road between this city and Grand Rapids. Eastern capital is reported to be behind the proposition.

Owosso, Mich.—Grand Trunk Ry., T. T. Irving, Resident Engineer, Detroit, Mich., proposes to build an extension to the Six Mile Creek coal mines. The extension will be about 10 miles long and will cost about $80,000. It is also possible that the road may be extended for four miles additional to New Lothrop and the Hazelton coal fields.

Lake Hopatcong, N. J.—Advices from New York report that the Delaware, Lackawanna & Western R. R., Lincoln Bush, Chief Engineer, Hoboken, N. J., opened bids May 30 on the construction of the proposed cut-off from Lake Hopatcong to a point just west of the Delaware Water Gap. The cut-off will be 28½ miles long and will cost about $10,000,000.

Pioneer, O.—Col. Jerry Boynton, Grand Rapids, Mich., is promoting project for the construction of a railroad from this place to Grand Rapids.

Poy Sippi, Wis.—Wisconsin & Northwestern Ry. Co. has been organized to build eight miles of road from Red Granite to this place. John Moffatt is President, C. A. Benedict is Secretary, and H. W. Colt is Treasurer. Arrangements are said to have been made with the Northwestern road to furnish its crew of surveyors to begin laying out the right of way next week.

Baker City, Ore.—Work is to be started about July 1, according to advices from this city, on the construction of the Eagle Valley R. R. The road will be narrow gage, extending from Baker City to a rich mining district 70 miles into the interior, where it will tap the Eagle and Pine Valleys and the rich copper country northwest of this city in the Cornucopia mountains. A. B. Jacobs, Cincinnati, O., is promoting the project.

Electric Railways.

Items Arranged Alphabetically by States.

Little Rock, Ark.—Local press reports quote President C. J. Kramer, of the Little Rock & Hot Springs Interurban, as stating that actual construction of the line will begin within 60 days.

Paris, Ark.—Construction of proposed Paris and Subiaco interurban line is to be started in September, according to a statement of G. G. Dandridge, of Paris. Projected length is over six miles.

Monrovia, Cal.—H. Kirchenschlager, Monrovia, has applied for franchises for a double track electric railway on several streets of this city.

San Francisco, Cal.—A. W. Maltby and Joseph Napthaly have been granted franchise to construct and operate an electric railway through the tunnel which penetrates the Berkeley hills, connecting Alameda and Contra Costa Counties.

Colorado Springs, Colo.—The Kansas-Colorado Railway Co., capitalization $5,000,000, and the Colorado Transportation Co., capitalization $5,000,000, have been organized to build an electric line from Garden City, Kan., up the Arkansas Valley to Canon City, Colorado Springs and Denver. Power and water will be furnished all towns on the route. Incorporators of both companies are: A. H. Atwater, Canon City, Colo.; J. A. Lockhart, Rocky Ford and Colorado Springs, Colo.; R. W. Patterson of La Junta, Colo., and A. H. Warner and Andrew Russell of Garden City, Kan. They will be directors for the first year, along with former Gov. Alva Adams and A. M. McClelland of Pueblo, Colo.; J. O. McDonald of Florence, Colo.; J. N. Beatty of Colorado Springs; Donald McIntosh of Las Animas, Colo.; W. C. Cloud of Lamar, Colo.; W. P. Humphrey of Syracuse, Kan., and W. O. Bourne of Scott City, Kan.

Grand Junction, Colo.—Morris K. Devereaux and Eugene Sunderlin, eastern capitalists, have applied to the City Council for a franchise to construct a street railway in Grand Junction. They agree to have three miles in operation in one year and to start construction work Oct. 15.

Danville, Ill.—Danville & Southeastern Ry. Co., L. E. Fisher, General Manager, has applied for franchises on a number of streets in this city.

Freeport, Ill.—Residents of this place are taking steps to secure the construction of an interurban railroad from Freeport northward through the villages of Cedarville, Red Oak, Buena Vista and Orangeville, Ill., and to Monroe, Wis., a distance of about 35 miles. C. C. Zimmerman and Henry Richart, Cedarville, Ill., are interested.

Fort Wayne.—Fort Wayne & Springfield Ry. Co. is considering extending its line from Decatur, Ind., to Lima, O., passing through Spencerville, Mendon and Rockford. Total length of route is 50 miles.

Gary, Ind.—Gary and Southern Traction Co. has been incorporated with capital stock of $10,000 to operate traction line between Gary and Crownpoint. John Brown, Crownpoint; Warren Bicknell, Cleveland, O.; H. W. Seaman, Clinton, Ia., and Frank M. Clark and Henry C. Wood, Chicago, are interested.

Hobart, Ind.—Garry-Hobart Electric Ry. Co., of Gary, has been incorporated. Capital stock is $10,000 and company proposes to operate a line in and between the cities of Gary, Liverpool, East Gary and Hobart. The directors are: L. Clark Wood, T. M. Campbell, Samuel A. Muhlhauser, William Earle and Carroll A. Teller.

Indianapolis, Ind.—With principal offices in this city and capital stock of $10,000 the Indianapolis, Cloverdale & Terre Haute Traction Co. has taken out new articles of incorporation and proposes to operate a traction line in and between the cities of Indianapolis, West Newton, Mooresville, Gasburg, Monrovia, Hall, Eminence, Cloverdale, Poland, Ashville, Brazil and Terre Haute. The directors are: E. M. Bowman, H. F. Butze, Samuel P. Axtell, William L. Cooke and Harry C. Sandresky.

Columbus, Mont.—Preliminary surveys are now under way for the interurban line which the Stillwater Power & Ry. Co. proposes to construct from Columbus to Cooke City, following the Stillwater River. It is stated that construction work will be started this year. Power will be developed from two falls on the Stillwater. Willard Bennett, Helena, Mont., is President of the Stillwater Power & Ry. Co.

Excelsior Springs, Mo.—City Council has granted a franchise to Excelsior Springs & Suburban Ry Co. to operate an electric line from the electric light plant to the C., M. & St. P. station, a distance of 1½ miles. Work will begin at once.

Guthrie, Okla.—The Guthrie & Interurban Ry. Co. of Guthrie, with $100,000 capital stock, has been chartered to build a line from Guthrie to a point on the Cimarron River, five miles out, at an estimated cost of $20,000 per mile. The incorporators are: C. R. Renfro, F. E. Houghton, F. G. Grow and R. E. Overton of Guthrie, and E. C. Brown of St. Louis.

Mutual, Okla.—E. O. McCance of Mutual is promoting the Canadian Valley R. R., an electric interurban enterprise, to be constructed from Mutual to Woodward and thence northward to Fort Supply, where the new Oklahoma insane asylum was recently established. Farmers along the route are interested in the proposition.

Walla Walla, Wash.—The Walla Walla Valley Traction Co., operating the street railway and the line to Milton, Ore., has applied to the County Commissioners for a franchise over the county roads from the south limits of the city to the north side of the Rensom Clark donation claim.

Appleton, Wis.—Wisconsin Traction, Light, Heat & Power Co., John S. Beggs, President, Milwaukee, is to extend its local street car line for a distance of about two miles.

Cheyenne, Wyo.—T. A. Cosgriff, Cheyenne, has applied for franchise for street railway in this city.

Sewers.

Items Arranged Alphabetically by States.

Prescott, Ark.—Ordinance is before City Council for organization of a sewer district practically covering entire town.

East San Jose (P. O. Sta., San Jose), Cal.—Trustees may call election to vote on bond issue for constructing sewers.

Bridgeport, Conn.—Hering & Fuller, Consulting Engineers, New York, have made a report to the Sewer Commission on the proposed new sewer system for this city. A bond issue may be recommended for the work, which will involve the expenditure of $750,000. George M. Eames is a member of the Commission.

Cedartown, Ga.—City has voted to issue $30,000 of bonds for sewer extensions and street improvement.

Grundy Center, Ia.—Chas. P. Chase Engineering Co., Clinton, Ia., is making surveys for a sewer system for this city.

Hamburg, Ia.—Mayor O. F. Redshaw will probably ask Council to take steps to secure estimates for constructing sewer system in city.

Aledo, Ill.—City is to at once take final action for construction of $16,500 sewer system. W. T. Church is Mayor.

Fulton, Ill.—City Council has been petitioned to bond for $5,000 for constructing sewers.

Fairbury, Ill.—Extension of city sewer system is advocated.

Logansport, Ind.—Board of Works is considering constructing sewer in East End to cost about $8,000.

South Bend, Ind.—Board Public Works will have hearing June 12 on constructing trunk sewer in Prairie Ave. A. J. Hammond is City Engineer.

Marion, Ind.—Estimates are being made by Thomas Petrie, City Civil Engineer, for proposed northwestern sewer.

Princeton, Ind.—Assistant City Engineer Campbell has completed plans for sanitary sewer system for city.

Shelbyville, Ind.—City Council is to engage engineer to prepare plans and specifications for the building of a general sewer system in this city.

Coffeyville, Kan.—City Council has adopted specifications for a septic tank for sewer Districts Nos. 1 and 3. Tank will be 96x50 ft. in size and will cost over $10,000.

Flint, Mich.—Council has voted to construct five new sewers in the 1st and 5th Wards

South Range, Mich.—Village Clerk has received plans and specifications for proposed sewer system, which, however, will probably not be constructed this summer.

Virginia, Minn.—Council is being petitioned to build system of sanitary sewers the present season throughout entire northwestern portion of the city.

Columbia, Miss.—A $50,000 bond issue has been voted for installing sewer system, water works and light plant.

Jackson, Miss.—Ordinance has been before Council providing for $196,000 bond issue for extending sewers, improving water works, etc.

Meridian, Miss.—W. G. Wetmore, City Engineer, has completed surveys for proposed sewer to Masonic Home, north of city.

St. Joseph, Mo.—Ordinance is now in preparation for a $250,000 bond issue for sewer extensions and repairs.

Dillon, Mont.—A 12-in. sewer is to be constructed in Sewer District No. 4 at a cost of $4,585. J. B. Poindexter is City Clerk.

Waterloo, N. Y.—The village has voted an appropriation of $100,000 for the construction of a sewer system and disposal plant. Bids for the work are now being taken. Morrison & Farrington, Inc., are the Engineers, 513 Dillage Bldg., Syracuse, N. Y.

Syracuse, N. Y.—Intercepting Sewer Board, Glen D. Holmes, Chief Engineer, has completed plans and specifications for the improvement of the Onondaga Creek from Spencer St. to South Ave. Work will cost about $75,000.

Point Pleasant, Pa.—Borough Council has appointed committee to submit plans for a sewer system.

David City, Neb.—A $17,000 bond issue has been voted for constructing sewer system, which will probably be built this year.

Lancaster, N. Y.—Sewer Commissioners have appointed Fairchild & Gatchell as supervising engineers for the building of the new sewer system here which is to cost about $150,000. A sewage disposal plant is also to be built.

Columbus, O.—Board Public Service has adopted plans and specifications for constructing sewer in Sullivant Ave. and bids will be called for at once. An appropriation of $55,000 has been made for the work.

Mount Vernon, O.—Riggs & Sherman, Toledo, O., are preparing plans and estimates for sewer system for this city. Population is about 10,000.

Dayton, O.—A $15,000 bond issue is to be made for cleaning sewers.

Chillicothe, O.—Jardine, Brewer & Tomlinson, Chillicothe, at $22,699, were reported to be low bidders May 28 for constructing 3,000 ft. of Honey Creek sewer.

Urbana, O.—Plans are being made for sewer system for this city.

Harrisburg, Pa.—State Health Department has taken action on the projected sewerage improvements of following towns and boroughs in the state, local officials of which can be addressed for further information: Derry Borough, plans for sewage disposal works approved; Indiana Borough, plans for sewage disposal approved; Mercer Borough, granted permission to build small sewer, with condition that plans be prepared for disposal; Exeter Borough, permission to construct storm water sewer—must plan disposal; Grove City Borough, decree forbidding sewer extension unless plans are made for disposal; Tarentum, Brackenridge and Natrona Boroughs, Allegheny County, suggested to unite in large sewer plant; Palmerton, Carbon County, plans for sewage disposal approved; Watsontown Borough, must submit plans for sewage disposal; Kane Borough, plans for sewage disposal approved; Wellsboro, order to prepare plans for sewage disposal.

Park (P. O. Station, Knoxville), Tenn.—A $130,000 bond issue has been voted by this city for sewer, street and fire department improvements.

Coleman, Tex.—Coleman Sewer Co. has been incorporated. Capital stock is $2,000 and incorporators include A. L. Coulson, R S. Bowen and J. M. Sewell.

Salt Lake City, Utah.—Ordinance has been before Council to submit a proposition to issue $600,000 worth of water and sewer bonds to a vote of the people

Bellingham, Wash.—City Council has passed resolutions for constructing a concrete outlet on C St. from Holly to Laurel, another for a sewer on Holly from Champion to C St., and the third for the section between C and E Sts

Potosi, Wis.—City has voted a $3,000 loan for building concrete storm water sewers.

SANITARY SEWERS.

Waterloo, Seneca Co., N. Y.

Sealed proposals will be received by the President of the Village of Waterloo, N. Y., until noon of July 1st, 1908, for furnishing the materials and constructing a system of sewers with sewage disposal plant for said village. The work will cover about fourteen miles of vitrified pipe, six to twenty inches, with trenching for same, four to sixteen feet deep, with manholes, flush tanks, river crossing and septic tank. Proposals will be received for the sewers and septic tank, separately and combined.

Plans, specifications and form of contract may be obtained of the Village President or from the engineers, Morrison & Farrington, Syracuse, N. Y.

Proposals must be accompanied by certified check for two thousand dollars that bidder will execute contract; and contractor will furnish bond for twenty thousand dollars for due performance of contract. The right to reject any and all bids is reserved.

June 4, 1908

JOHN KROPF,
Village President.

24-3t

CONTENTS OF JUNE 3, ISSUE OF ENGINEERING-CONTRACTING.

EDITORIAL:

What Is the Practical Value of Hooping as a Method of Reinforcing Concrete Columns.................327
The Kind of Cuts to Use in Advertising and the Kind Not to Use......327
A Legal Decision of Interest to Contractors 328

CONCRETE SECTION:

Results of Tests of Hooped Concrete Columns at the University of Illinois Engineering Experiment Station 329

EARTH AND ROCK SECTION:

Method and Cost of Blasting 1,100 Stumps 336
A Tunnel Excavating Machine for Soft Material.....................337

ROADS AND STREETS SECTION:

Data on Tarvia Road Treatment in New York State and Tar Macadam Work in Canada.................337
Methods of Dragging Earth Roads...340

WATER WORKS AND SEWER SECTION:

Method and Cost of Building a Pipe Sewer Through Quicksand by Excavating the Ground with a Pump..341

RAILWAY SECTION:

Itemized Cost of the Stampede Tunnel (9,850 Lin Ft), and Its Masonry Lining...........................342

STRUCTURAL STEEL SECTION:

Method of Erecting a Steel Bridge by Launching 344

GENERAL ARTICLES:

Card Index Order System...........348

CONCRETE PAVEMENTS.

Bozeman, Montana.

Sealed proposals will be received at the office of the undersigned in the City of Bozeman, Montana, until 7:30 o'clock p. m. on the 2d day of July, 1908, for the construction of concrete pavements on Main street in said city from Wallace avenue to Fourth avenue, twenty-five thousand (25,000) square yards, more or less.

Said proposals shall be for doing the work in accordance with the plans and general specifications on file in this office, and which may also be seen at the office of the City Engineer.

Each proposal must be accompanied by specifications in detail as to the proposed method of construction and materials to be used.

Proposals should be made upon the forms attached to the general specifications and must be accompanied by a certified Chicago check for one thousand ($1,000) dollars, payable to the City Treasurer of the City of Bozeman.

The right is reserved to reject any or all bids. By order of the City Council, June 4th, 1908.

H. H. HOLLOWAY,
City Clerk.

24-3t

ADDRESSOGRAPH
with 6,000 stencils, cabinets, etc.
complete. Nearly new.
VERY CHEAP.
"Box 12" care of Engineering-Contracting

PROPOSALS FOR EXTENSION OF FILTRATION WORK.

Pittsburg, Pa., June 10th, 1908.

I. Sealed bids or proposals for the construction of filters, pipe gallery, conduits, piping, fixtures and appurtenances in O'Hara Township, Allegheny County, Pennsylvania, for the City of Pittsburg, and endorsed "Proposal for Extension of Filtration Works, Contract 11, Bureau of Filtration, Department of Public Works," will be received at the office of the City Controller, Municipal Hall, Pittsburg, Pa., until 10:00 a. m., Monday, the twenty-ninth day of June, 1908, and will be publicly opened and read in Common Council Chamber, Municipal Hall, on Monday, the twenty-ninth day of June, 1908, at 10.15 a. m.

II. All bids shall be made upon the blank forms of the proposal, attached to the contract and specifications, to be obtained, on and after Wednesday, the tenth (10th) day of June, 1908, at the City Office of the Bureau of Filtration, in Municipal Hall, Pittsburg, Pennsylvania.

III. Each proposal shall be accompanied by a legally executed bond, of a security or trust company, which has complied with the City Ordinances, in reference to furnishing bonds for city contracts, to the amount of two hundred thousand ($200,000) dollars, which shall be held as security for the execution and faithful performance of the contract.

IV. Blue prints of contract plans and copies of the specifications can be seen at the office of the Department of Public Works, Municipal Hall, Pittsburg, Pennsylvania, and also at the Field Office of the Bureau of Filtration, near the site of the proposed work, in O'Hara Township, Allegheny, Pennsylvania; also at the office of Engineering-Contracting, 255 Dearborn St., Chicago, Ill.

A limited edition of the printed pamphlets of contract and specifications and of blue prints of contract plans can be obtained at the City Office of the Bureau of Filtration, in Municipal Hall, Pittsburg, Pennsylvania, by bona-fide intending bidders; but in each case a deposit of ten ($10.00) dollars will be required for each copy of the pamphlet and of fifty ($50.00) dollars for each set of contract blue prints so obtained. Proper receipt for each such deposit will be given which said amounts of money will be returned to the bidder when pamphlets and blue prints are returned in good condition to the office, or in case the pamphlet be used in filing a bid.

V. The property occupied by the City for a Filtration Works, lies along the Allegheny River and on both sides of the Conemaugh Division of the Pennsylvania Railroad. The Extension consists of the building of ten (10) covered filters of one acre each with the necessary Conduits, Steel Pipe, Cast Iron Pipe, Gate Valves and appurtenances.

Included among other items, there are approximately the following quantities:

230,000	cubic yards of excavation.
230,000	cubic yards of embankment and fill
33,500	cubic yards of concrete.
145	tons of steel pipe.
130	tons of cast iron pipe and specials.

All quantities given are approximate, and the Mayor and the Director of the Department of Public Works reserve the right to increase or decrease the amount of any class or portion of the work as they deem necessary and to reject any or all proposals, or accept any proposal, if they deem it to the interest of the City of Pittsburg so to do.

GEORGE W. GUTHRIE,
Mayor.
ALEXANDER B. SHEPHERD,
Acting Director Dept. of Public Works.
MORRIS KNOWLES,
Engineer.

24-2t

THE
NEW YORK CONTINENTAL JEWELL
FILTRATION COMPANY
FILTERS
General Contractors
CHICAGO NEW YORK

NATURE ADORNED
My booklet gives some interesting data on what may be accomplished in beautifying and improving the landscape. Engineers, city and railroad officials should send for it.
F. R. MEIER, 1 Broadway, NEW YORK
Consulting Forester

THE JOHNSON
Well Screen
All sizes. Brass. Large Capacity.
Non-choking. Used everywhere.
WRITE FOR BOOKLET "EC."
E. E. JOHNSON, St. Paul, Minn.

Prompt Shipments
BEST EXTENSIBLE TRENCHING BRACE MADE
KALAMAZOO, FDRY. & MACHINE CO MICHIGAN
898 EAST MAIN ST.

Contractors' Supplies and Heavy Hardware
Lead Furnaces
Jute Packing
Joint Runners
Calking Tools
All Kinds of Castings to Order
SCOVIL MFG. & SUPPLY CO., 639-641 Greenwich Street
New York City

ESTABLISHED 1820
YOUNG & SONS
MANUFACTURERS OF
ENGINEERING MINING AND
SURVEYING INSTRUMENTS
PHILADELPHIA

CONTRACTORS AND ENGINEERS
USE
Nash's Expeditious Measurer
A book of 200 pages of indexed tables, showing at a glance the cubic contents of any stone or package according to its length, breadth and depth. Used by Contractors, Quarrymen and Engineers everywhere. Order of your bookseller or the publisher. **$2.00 Postpaid.**
A. L. NASH
17 State Street NEW YORK
Send for Sample Pages
SAVE LABOR
SAVE TIME
AVOID ERRORS

The world's authority on this great subject
The most expensive book ever issued and sold for only $5.00

Concrete and Reinforced Concrete Construction

By HOMER A. REID, Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; $5 net postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete, on doing concrete work in freezing weather, on facing and finishing concrete, on waterproofing concrete on the physical properties of concrete, on cement testing and on concrete block manufacture and construction.

This book contains more text pages, more drawings and more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter—material never previously published. This work is a combination of several books in one; it is complete, up-to-date and original. No other book on concrete contains one-tenth as much of the very latest data on tests, theory and practice. The cost to publish this book has been more than double the original estimate, but the price will for the present remain at $5 net postpaid.

WRITE FOR 16-PAGE TABLE OF CONTENTS.

THE MYRON C. CLARK PUBLISHING CO.

Eastern Offices
13-21 Park Row, New York

355 Dearborn Street, Chicago

Have You Contract Work to be Done This Year?

Engineering-Contracting offers you the means of getting the news of this work widely and quickly to contractors who will bid on doing it. It distributes the news widely because its circulation is large and because its readers are specifically men who do work—contractors, constructing engineers, manufacturers of construction materials and supplies. It distributes this news quickly because it is printed in Chicago, and reaches subscribers west of Pittsburg 24 to 48 hours sooner than can any New York paper. Its circulation among middle western contractors is particularly large.

Wide and quick publication of work to be contracted means wide competition and prompt and careful bidding and these mean to the owner reliable work at the lowest cost. A trial proposal advertisement in ENGINEERING-CONTRACTING has convinced officials of other cities of the truth of these assertions. A trial advertisement will convince you. It will cost only $2.40 an inch.

This is a small sum to risk on a chance merely of securing wide competition, but we would not ask you to risk even so small a sum were we not convinced from results given to others that the chance is no chance, but a certainty. Will you not demonstrate the fact to yourself by a trial "Proposal" in our columns?

ENGINEERING-CONTRACTING, 355 Dearborn Street, CHICAGO

Edson Diaphram Trench Pumps

THE EDSON PUMP

was the FIRST **DIAPHRAGM PUMP** ever made. Experience counts for something. IT is the accepted STANDARD all over the world.

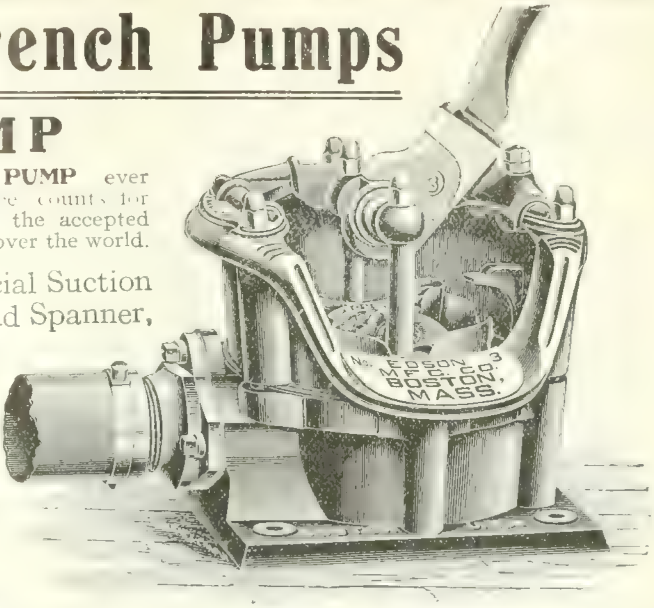
Complete Outfits, including Pump, Edson Special Suction Hose, Extra heavy Brass Couplings, Strainer and Spanner, **ready for business.** Extra lengths of **Suction Hose,** guaranteed **Diaphragms** and duplicate Pump parts, **carried in stock.**

SEND FOR DESCRIPTIVE CATALOG

Established 1859

EDSON MFG. CO.

256 Atlantic Avenue Boston, Mass.



ELECTRICAL AND PUMPING MACHINERY.

ALGIERS SEWERAGE STATION "C"—Office of the Sewerage and Water Board, 602-604 Carondelet street, New Orleans, La., April 14th, 1908.

Sealed proposals will be received until 3 o'clock p. m., Tuesday, June 30th, 1908, for furnishing and erecting the following machinery:

2—100 K. W. 250 volt, direct current generators.

2—75 H. P. 250 volt motors.

1—2,500,000 gallon turbine pump, to work against a 125 foot head, directly connected to an electric motor.

1 1,000,000 gallon triplex pump, to work against a 125 foot head, geared to an electric motor.

1—2,000,000 gallon centrifugal pump unit, to work against a 20 foot head.

2—4,000,000 gallon centrifugal pump units, to work against a 20 foot head.

2—5 H. P. 250 volt motors.

1—Surface condenser, capable of condensing 6,500 pounds of steam per hour; together with air pump.

Also all exhaust and water piping, valves, wiring, switchboard, lights, and other appurtenances, completely erected.

Specifications with blank form of proposals may be obtained at the office of the Board. Plans will only be furnished upon personal application.

A certified check on a New Orleans bank, in the sum of $1,000, deposited in accordance with the terms of the specifications will be required of each bidder.

A surety company bond in an amount equal to 25 per cent. of the gross amount of the contract, with a surety company doing business in the State of Louisiana and acceptable to the Sewerage and Water Board, will be required of the successful bidder.

The right is reserved to reject all bids

F. S. SHIELDS,
GEO. G. EARL, Secretary.
General Superintendent. 17-10t

PAVING.

Montgomery, Ala.

Sealed proposals in duplicate will be received by Robert Tait, City Treasurer, Montgomery, Ala., until 12 o'clock, noon, June 15, 1908, for paving the roadway (street) of North Court street, from the south side of Pollard street to the city limits, with asphalt, brick, bitulithic or Belgian blocks, in accordance with specifications in the office of A. R. Gilchrist, City Engineer, Montgomery, Ala.

All bids to be accompanied by a certified check for $5,000.

The City Council of Montgomery reserves the option of paying for said paving in bonds at par and accrued interest, or cash; also reserves the right to reject any and all bids.

ROBERT TAIT,
23-1t City Treasurer.

AQUEDUCT.

Board of Public Works,
Los Angeles, Cal., May 15, 1908.

Sealed proposals will be received at the office of the Board of Public Works, July 17th, 1908, for the construction of the Jawbone Division of the Los Angeles Aqueduct, with a capacity of four hundred second feet, including about forty-three thousand lineal feet of lined tunnel, sixty thousand lineal feet of lined conduit, and three hundred forty thousand cubic yards of excavation. The work is subdivided into three sections, and separate or lump sum proposals will be received. Plans and specifications may be obtained from the Board.

HORACE B. FERRIS,
23-3t Secretary.

MISSISSIPPI RIVER COMMISSION, 1st and 2d Districts, U. S. Engineer Office, Room 20, Custom House, Memphis, Tenn., May 16, 1908. Sealed proposals, in duplicate, for about 540,000 cubic yards of levee work in Upper and Lower St. Francis Levee Districts will be received at this office until 12 o'clock, noon, June 16, 1908, and then publicly opened. Information furnished on application. WM. D. CONNOR, Capt. Engrs. 21-4t

If you want

**Tools
Supplies or
Machinery**

Or if you desire catalogs or prices, or other information concerning anything, **send us a postal card** and we will notify the leading dealers or manufacturers. We have *unexcelled facilities* for helping those who are in the market for anything.

Engineering - Contracting
355 Dearborn St., Chicago

715 Illustrations; 70 Tables and 906 Pages
Shows the size of Mr. Homer A. Reid's book.

"Concrete and Reinforced Concrete Construction"

Price, $5 net, postpaid

This book contains more text pages, more drawings, more tables of text data, more ORIGINAL matter, than any other book or books ever published on this subject.

WRITE FOR 16-PAGE TABLE OF CONTENTS

The Myron C. Clark Publishing Co.
355 Dearborn Street :: CHICAGO, ILL.

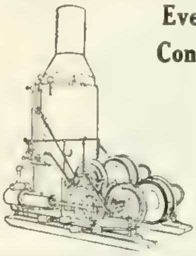
WANT ADVERTISEMENTS in ENGINEERING-CONTRACTING, if undisplayed, cost only **ONE CENT A WORD**
Displayed "Want" and "For Sale" Cards, $1.00 an inch.

In a Hurry?—Send to Hough

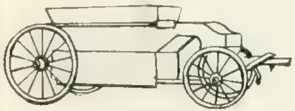
EXPEDITION FOR CONTRACTORS

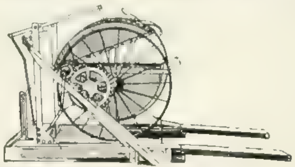
in the completion of work is made possible by our ability to ship from our big new warehouse

Everything Needful in Contractors' Equipment

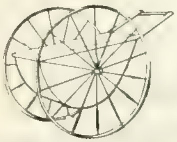

Buffalo Hoisting Engines

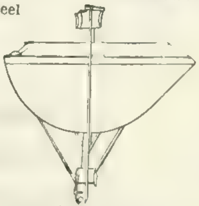
Ransome Concrete Mixers


Troy Wagons

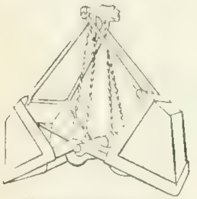

Street and Sidewalk Concrete Mixers

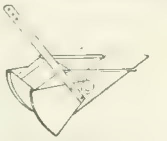
M-B Cold Twisted Steel


Ransome Concrete Carts

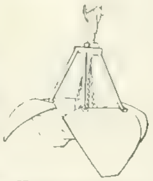

Automatic Dump Concrete Hoist Buckets

Swivel Concrete Cars

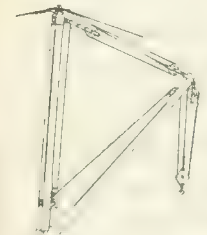

Hercules Clam Shell Buckets

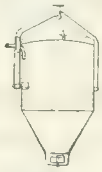

Sand, Stone and Concrete Bin Gates

Self-righting Buckets

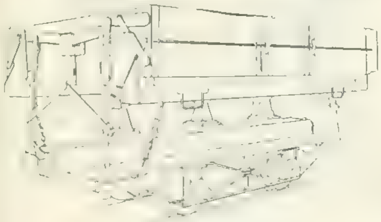

Hercules Orange Peel Buckets

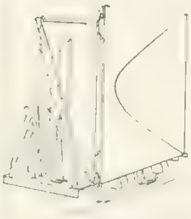
Balanced Cableway Cranes


Derricks


Bottom Discharge Concrete Buckets

Charging Barrows


Peteler Two-way Dump Cars


Two-way Side-Dump Concrete Cars

These cuts illustrate only a part of our complete line.

We are furnishing plants for every conceivable contractors' purpose Probably we can suggest some better way of doing your work

Our machinery is built to stand up under severe service It is **always on the job doing the work.**

W[illegible] your job [illegible] and at a profit We ca[illegible] yo[illegible].

Write or wire us your requirements.

William B. Hough Company

Monadnock Block

CHICAGO U. S. A.

This Is A Sample of Useful Hydraulic Data in

For 1 Foot in Length.						
Diam. in.	Cubic Ft. also Area in Sq Ft	U. S. Gals., 231 Cubic in.	Area, Sq. in.	Circm. Circles inches.	Weight water in 100 ft. Pipe	
					Dia Pip in.	Lbs. in 100 Ft.
¼	.0003	0025	.04909	.785		
5-16	0005	004	.0767	981		
⅜	.0008	0057	.11045	1.178		
7-16	001	0078	.15033	1.374		
½	.0014	.0102	.19635	1.570		
9-16	.0017	.0129	.2485	1.767		
⅝	.0021	.0159	.3068	1.963	1¼	104.27
11-16	.0026	.0193	.37122	2 159		
¾	.0031	.0230	.44179	2.356	2	136.20
13-16	.0036	.0269	51849	2.552		
⅞	0042	.0312	60132	2.748	2¼	172.37
15-16	0048	.0359	69029	2.945		
1	0055	.0408	.7854	3.141	2½	212.8
1¼	.0085	.0638	1.2272	3.927		
1½	.0123	.0918	1.7671	4.712	2¾	257.48
1¾	.0167	.1249	2.4053	5.497	3	306 43
2	.0218	.1632	3.1416	6.283		
2¼	.0276	.2066	3.9761	7.068	3¼	359 63
2½	.0341	.2550	4.9087	7.854		
2¾	.0412	.3085	5.9396	8.639	3½	417.08
3	.0491	.3672	7.0686	9.424	3¾	478.8
3¼	.0576	.4309	8.2958	10 210		
3½	.0668	.4998	9.6211	10.995	4	544 76
3¾	.0767	.5738	11.045	11.781		
4	.0873	.6528	12.566	12 566	4¼	614.98
4¼	.0985	.7369	14.186	13.351	4½	689.46
4½	.1134	.8263	15 904	14.137		
4¾	.1231	9206	17.721	14 922	4¾	768.2
5	.1364	1.020	19 635	15.708		
5¼	.1503	1.125	21.648	16.493	5	851.19
5½	.1650	1.234	23 758	17 278		
5¾	.1803	1.349	25 967	18 064	5¾	1125.7
6	.1963	1 469	28 274	18 849		
6¼	.2131	1.594	30 680	19.635	6	1225.7
6½	.2304	1.724	33.183	20.420		
6¾	2485	1 859	35 785	21 205	6½	1438.5
7	.2673	1 999	38 485	21.991		
7¼	2867	2 145	41 282	22 776	6¾	1551.29
7½	.3068	2 295	44.179	23 562		
7¾	.3276	2.45	47.173	24 347	7	1668.33
8	.3492	2 611	50 265	25 132	7½	1915.18
8¼	.3712	2 777	53 456	25 918		
8½	3941	2 948	56 745	26 703	8	2179 04
8¾	.4176	3 125	60 132	27 489		
9	.4418	3.305	63.617	28.274	8½	2459 94
9¼	.4667	3 491	67 201	29 059	9	2757.85
9½	.4922	3 682	70 882	29 845		
9¾	.5185	3 879	74 662	30 630	9½	3072 79
10	.5454	4 08	78 54	31 416		
10¼	.5730	4.286	82 516	32 201	10	3404 76
10½	.6013	4 498	86 59	32 986	10½	3753.74
10¾	.6303	4.715	90 763	33 772		
11	.66	4 937	95 033	34 557	11	4119.75
11¼	.6903	5 164	99 402	35 343		
11½	.7213	5 396	103 87	36.128	11½	4502 79
11¾	.7530	5 633	108.43	36 913		
12	.7854	5.875	113.1	37 699	12	4902 85
12½	.8522	6 375	122 72	39 270		
13	.9218	6 895	132 73	40 840	12½	5319.93
13½	.994	7 436	143 14	42 411		
14	1.069	7 997	153 94	43 982	13	5754 04
14½	1 147	8 578	165 13	45 553		
15	1 227	9 180	176 71	47 124	14	6673 32
15½	1.310	9 801	188 69	48 694		
16	1 396	10 44	201 06	50 265	15	7660.7
16½	1 485	11 11	213 82	51 836		
17	1.576	11 79	226 98	53 407	...	......
17½	1 670	12 49	240 53	54 978		
18	1 768	13 22	254 47	56 548	...	....
18½	1.867	13.96	268.80	58.119	...	....

Our Bulletin 97EC.

Every engineer and contractor should have a copy of our catalog on file; for the information in the catalog is invaluable in selecting the kind and size of pump to be used for any given purpose. The American Well Works have been makers of pumps of all kinds and of well drilling machinery for 36 years, and have produced machinery of the highest efficiency. Familiarize yourself with what has been accomplished by sending for our catalog.

Besides giving the information as per headings, the second and third column from the left hand will readily indicate the cubic feet of free air per minute obtainable from a single acting air compressor, or, if using a double acting air compressor, double the figures. The third column also indicates the quantity of water handled per minute by a single acting water cylinder working at an up-piston foot stroke of 100 ft. per minute.

BETTER SEND FOR BULLETIN 97EC AND GIVE SPECIFICATIONS OF WORK ON HAND.

THE AMERICAN WELL WORKS

AURORA, ILLINOIS

Why Buy An Outfit? We Will Rent You One

Does lack of plant deter you from bidding on some attractive job in your vicinity—some job in which you can see money if you only had the plant to handle it? Our business is to supply this plant on lease. We own over a million dollars' worth of general and special contractors' plant for you to draw from. Any part of this plant will be rented to you at a price per cubic yard, per day, per month or per year. This price, moreover, will be such that you can make money on the contract, and you can pay our rental out of your monthly estimates. You invest no capital in plant and have no idle plant on your hands when the work is done. Do you know of a simpler method of financing a construction job? Our offer is as wide open to the small contractor as it is to the large one. WRITE, WIRE OR CALL.

UNITED STATES EQUIPMENT COMPANY

FISHER BUILDING, CHICAGO

FOR SALE

Five-ton Northern, standard gauge, full circle

LOCOMOTIVE CRANE

with 25 ft. boom, now being rebuilt at Chicago shops and arranged to handle small clam or orange peel.

Ready about April 15th.
Will be good as new.

WILLIS SHAW
171 La Salle Street, Chicago

FOR SALE

Contractors' Equipment

32 H. P. Portable Boiler.
No. 0, No. 1, No. 2 Smith Mixers.
Single Drum and Double Drum Hoisting Engines.
½-Yard Cube Mixers.
½-Yard Ransome Mixers.
All Round Wiener Dump Cars.

Description on Request.

Address, F. S. ROBINSON, 701 Owen Bldg., Detroit, Mich.

REID'S

"Concrete and Reinforced Concrete Construction" is the world's authority on this important subject. 906 pp.; 715 illustrations; 70 tables. $5.00 net; 16-page circular free.

WRECKING CITY HALL.

Department of Public Works,
Chicago, May 12, 1908.

Sealed proposals will be received by the city of Chicago until 11 a. m., Tuesday, July 14, 1908, at Room 224, City Hall, for the wrecking, excavating, and caissons required in connection with the construction of the new City Hall building to be erected on the west half of block 39, original town of Chicago, according to plans and specifications on file in the office of Holabird & Roche, Architects, 16th floor, Monadnock Block.

Proposals must be made out upon blanks furnished at said office, and be addressed to said department, indorsed "Proposals for New City Hall, Wrecking, Excavating, and Caissons," and be accompanied with five (5%) per cent of amount of bid in money or a certified check for the same amount on some responsible bank located and doing business in the city of Chicago and made payable to the order of the Commissioner of Public Works.

The Commissioner of Public Works reserves the right to reject any or all bids. A deposit of $500 will be made in Room 224, City Hall, to insure the safe return of plans and specifications.

No proposal will be considered unless the party offering it shall furnish evidence satisfactory to the Commissioner of Public Works of his ability, and that he has the necessary facilities, together with sufficient pecuniary resources, to fulfill the conditions of the contract and specifications, provided such contract should be awarded to him.

Companies or firms bidding will give the individual names, as well as the name of the firm, with their address.

JOHN J. HANBERG,
Commissioner of Public Works.
By PAUL REDIESKE,
Deputy Commissioner. 23-2t

FOR SALE

Second-Hand Machinery

In First-Class Condition

1 125 H.P. Erie City **ENGINE.**
1 125 H.P. "American" **ENGINE.**
1 Economic **BOILER** (125 H.P.)
1 Tubular **BOILER** (125 H.P.)
13 3-yard Western **DUMP CARS** (36" gauge.)
56 10-yard Western **DUMP CARS** (standard gauge.)
46 2-yard **SKIP CARS** (36" gauge.)
2 Imperial (Rand) **AIR COMPRESSORS** complete—1,700 cubic feet capacity each.
2 170 H.P. **BOILERS.**
2 150 H.P. **BOILERS.**
2 Gardner **FEED PUMPS.**
3 12-inch Morris **CENTRIFUGAL PUMPS** with engines.
35 Little Giant **DRILLS** with drill steels and repair parts.
4 Sullivan Rock **CHANNELLERS.**
Track, steels and other small tools, etc.

Apply to
SANITARY DISTRICT OF CHICAGO
1500 American Trust Building CHICAGO
Telephone 624 Central

"WANT"

Cards in this paper cost, if undisplayed, only

One Cent a Word

Displayed $1.00 an inch.

WANTS

Undisplayed Cards under this heading cost only

One Cent a Word

Displayed $1 00 an Inch.

TECHNICAL MEN superintendents, engineers and] draftsmen. Openings in all parts of the world at the highest possible salaries. Write us today of your experience. Hapgoods, 305 Broadway, New York City, or Suite 1012 Hartford Building, Chicago.

WANTED—Catalogs and booklets pertaining to municipal and general engineering. D. L. Yarnell, Asst. City Engineer, Le Mars, Iowa.

WANTED—MEN—Soft ground tunnel foreman and laborers, Louisville, Ky. Long job and good wages. Address The E. G. Nave Bros. Co., Story and Bickle Aves., Louisville, Ky. 24-4t

WANTED—Position.—Tunnel superintendent with complete organization. Soft ground, rock or compressed air. Open for engagement June 1. Address "Tunnel Supt.," care Engineering-Contracting, 13-21 Park Row, New York.

WANTED—Position as superintendent or foreman of concrete construction. Several years' experience. Middle or Southern States preferred, but will go anywhere. Address Box 414, Jackson, Tenn.

WANTED—Position as foreman on bridge or building work after June 5. Fifteen years' experience bridges, foundations, factory buildings and reinforced concrete bridge work. Address Box 36, care Engineering-Contracting, 355 Dearborn St., Chicago, Ill. 22-4t

WANTED—Position as cement physical tester, concrete foreman or inspector with municipality or contractor, by young engineer now in charge of experimental laboratory of large cement plant. Address Box 38, care Engineering-Contracting, 355 Dearborn St., Chicago. 23-4t

WANTED—Position as Mechanical Draftsman by young engineer with 4 years' experience. Willing to commence with moderate salary where opportunity to learn and advance is offered. Address Box 37, care Engineering-Contracting, 355 Dearborn St., Chicago. 22-2t

WANTED—Position.—By young engineer with two years' experience in general field work and drafting. Good draftsman and instrument man. Position desired offering permanency of location. Assistant in city preferred. Address Box 35, care Engineering-Contracting, 355 Dearborn St., Chicago. 21-6t

WANTED—Position as construction engineer or contractor's superintendent, by graduate civil engineer 28 years old. Five years' experience on design and erection of structures of steel and reinforced concrete. Best of references. Address Box 34, care Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Position. Technical graduate, age 26, wishes permanent or temporary position. Four years' exprience in state highway, municipal and mill construction and maintenance work. Small salary to start if there is chance for advancement. Address Box 39, care of Engineering-Contracting, 355 Dearborn St., Chicago. 24-2t

WANTED—Will pay 15 cents each for one perfect copy of Engineering-Contracting for each of the following dates: July 3, 1907; July 10, 1907; August 7, 1907. These papers are wanted to complete files for binding. All reading pages must therefore be in perfect condition. Address "P. V. C.," care Engineering-Contracting, 355 Dearborn St., Chicago. 21-tf

WANTED, POSITION — Have had seven years' contracting experience. First four years timekeeper, material man, paymaster and cost-keeper. Last three in charge of grading, masonry and concrete. Best reference. Am also Powell student of advertising. Desire permanent position with contractor or in publicity department of manufacturing or supply firm. Am twenty-nine and married. Will accept anything, anywhere, if there is an opportunity for demonstrated ability to make good and stick. Address Box 40, care of Engineering-Contracting, 355 Dearborn St., Chicago. 24-1t

STUDY OUR
CONCRETE
COURSES
Reinforced Concrete Design; Concrete Construction and Contracting.
CIRCULAR EXPLAINS
CONCRETE ENGINEERING
584 Caxton Bldg., Cleveland

FOR SALE
Two 10"x40" Buchanan duplex jaw
CRUSHERS
will crush 24 to 30 tons per hour, using 28 to 35 h. p., weight 28,000 lbs.
Four No. 7 Marvin Electric
ROCK DRILLS
with tripods, drill 6½' per hour. Use about 8 h. p. One 30 h. p. 180 volt GENERATOR (alternating current) made for use with these drills.
All in good condition.
ALSENS AMERICAN PORTLAND CEMENT WORKS
45 Broadway, New York City, N. Y.

FOR SALE
1 Kearns **Revolving Excavator,** 1½ yard Orange-Peel Bucket, 65 ft. boom.
Two 36" gauge **Saddle Tank Locomotives,** 12 ton.
One 15 ton, 36" gauge **Saddle Tank Locomotive.**
New light rails and standard section **relayers** of all weights.
BLOCK=POLLAK IRON CO.,
Chicago Cincinnati St. Louis
Yards, East Chicago, Indiana

FOR SALE—GREAT BARGAIN
TWO BUCKEYE
Traction Ditcher Machines.
One machine cuts a trench 24 inches wide by 7½ feet deep; has been used 4 months; at full depth it digs from 400 to 600 feet per day.
The other machine cuts a trench 15 inches wide by 5½ feet deep; for laying tile in fields; digs from 825 to 1650 lineal feet per day; has been used one year.
These machines have the latest improved patented leaning device (patented Jan. 7, 1908).
Will also sell patent, allowed May 25, 1908, for self-tiling and quicksand protection.
Going out of business on account of ill health; will give a bargain.
T. De Young & Sons, So. Holland, Ill.

J. F. GRAHAM
(Roadmaster Graham)
RAILROAD LABOR AGENT
All classes of Laborers in Any Number
SUPPLIED FREE
Competent Foremen a Specialty.
Services Guaranteed Satisfactory.
WRITE OR WIRE
204 Washington Avenue South
MINNEAPOLIS, MINN.

FOR SALE
SMITH CONCRETE MIXER
at less than half cost
Good Condition
ALSO ONE BATCH MIXER
STANDARD SCALE & SUPPLY CO.
50 and 54 South Canal Street, Chicago, Ill.

FOR SALE
Wheelbarrows
second hand
and **Complete Equipment for Concrete Contractor.**
Call at 1115-17 Schiller Building,
103 Randolph Street, CHICAGO

FOR SALE OR RENT
Two Vulcan **shovels,** 1¼ yard and 2½ yard, 3 sets engines.
Two 42" gauge saddle tank 9 x 14, **locomotives,** saddle tank.
Two 36" gauge **locomotives,** saddle tank, 9 x 14.
30 and 56 lb. **relayers** with plates.
Traction engines, hoisting engines, pumps, etc.
HARPER MACHINERY COMPANY
1861 Fulton Bldg., Hudson Terminals,
50 Church Street, New York
Yards and Shops, Bloomfield N. J.

FOR SALE
One Sioux City Corliss Compound Tandem
ENGINE
14x26x36, Fly Wheel 25¾ inch face, 14 ft. 4 in. diameter.
Three 72 inch by 18 feet return flue
BOILERS
Address L. D. WRIGHT,
Water Commissioner, Fremont, Nebraska

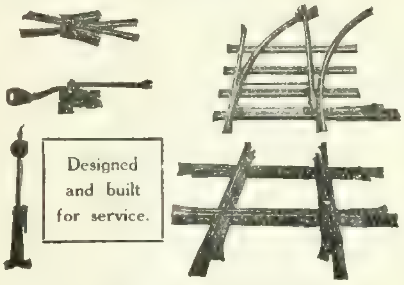
FOR SALE
1 Carson **Trench Machine.** Fine condition. Cost new $3,000.00. Will sell for.................. **$1,700**
1 ¾-yd. Smith **Mixer** on trucks, with engine.
10 1-yd. K. & J. **Scrapers.** Fine shape.
2 1¼-yd. Oliver rotary **Cars. Cheap.**
1 8-wheel **Locomotive,** just overhauled and in fine condition. Price..... **$2,000**
Write us for anything you may be needing in the line of Contractors' equipment.
R. G. LUCAS & CO.
MARION, OHIO.

The Cincinnati
Frog & Switch Co.
CINCINNATI, OHIO
Manufacturers of
Frogs, Crossings, Switches,
Switch Stands, Rail Braces,

And special track work of every description for Railroads, Mines, Mills, Contractors, Plantations.

FROGS, SWITCHES, CROSSINGS

Stands and Portable Track for all weights of rail for Quarries, Mines, Coal Tipples, Industrial Plants and Contractors' use.



Designed
and built
for service.

Catalogue and prices upon request

THE INDIANAPOLIS SWITCH & FROG CO.
SPRINGFIELD, OHIO

RARE BARGAINS in RAILS
and EQUIPMENT
WALTER A. "ZELNICKER" SUPPLY CO.
in ST. LOUIS
DO YOU RECEIVE OUR STOCK LISTS?

LOCOMOTIVES

Eight 9x14 saddle tank 36-inch gauge. Also lighter and heavier locomotives. Have 165 locomotives from 6 to 70 tons in stock in our shops.

Also STEAM SHOVELS

Southern Iron & Equipment Co.
ATLANTA, GA.

Largest Dealers in Rebuilt
Equipment in United States

EAST WORKS
New Freight and Passenger Cars

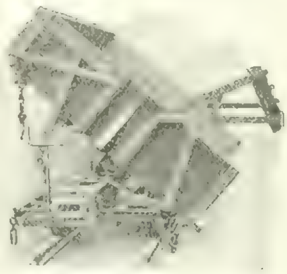
WEST WORKS
Rebuilt Coaches, Cars and Engines

Hicks Locomotive & Car Works
General Offices
Chicago Heights, Illinois
Sales Dept.
Fisher Building, Chicago, Ill.
Eastern Representatives
Empire Steel & Equipment Co., 141 Broadway, New York.

Steam Shovels, Locomotives,
Cars, etc.
Contractors' and Railway Equipment
Telegraph, Telephone or Write Us.
A. C. TORBERT & CO.
647-548 Monadnock Block CHICAGO

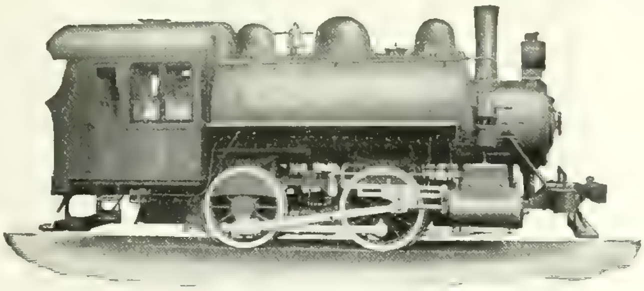
VULCAN IRON WORKS
CHICAGO
PILE DRIVERS

"CONTINENTAL"
DUMP CARS



1½ to 20 Cubic Yards Capacity,
any Guage
Continental Car & Equipment Co., (Inc.)
17 Battery Place, New York
Highland Park, Louisville, Ky.

LIGHT LOCOMOTIVES



For contractors, mines, plantations, industrial plants and light switching service generally.

Standard types in stock for immediate shipment. Any desired design built to suit purchasers' requirements.

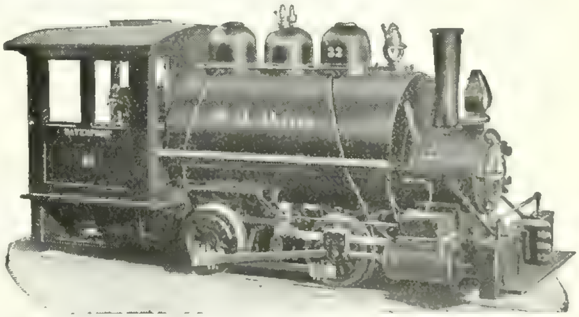
Interchangeable spare parts always on hand.

AMERICAN LOCOMOTIVE COMPANY
30 Church Street, New York

Davenport Contractors' Locomotives

Excel in Hauling Capacity as well as in working and wearing qualities—That's why so many contractors use them exclusively

We build a contractor's locomotive—not merely a locomotive that can be used by contractors. This being our business, we have made it a point *to learn* by study and experiment the things that a contractor wants in a locomotive, and after learning, *to provide* these needed things in **Our Locomotive.** A contractor's locomotive has hard usage, and not the best care—good material and good workmanship are, therefore, essential, and we provide both. A contractor's locomotive must have hauling capacity—we guarantee **Davenport Locomotives** to haul more, size for size of cylinders, than any other. A contractor's locomotive has to be simple and easy to repair—**Davenport Locomotives** have interchangeable parts, and these parts are always kept in stock. We demonstrate all these claims in our CATALOG "EC." Send for it, and if you are ever in Davenport come and see our plant—we feel proud of it.



DAVENPORT LOCOMOTIVE WORKS, Davenport, Iowa

List of Contractors' Supplies.

If you wish the catalogs of the leading manufacturers of any tool or machine mentioned below, send us a postal card, giving your address and business, and the list number of article of which you want catalogs.

This will save you the trouble of writing several letters to different manufacturers. Should you later on have correspondence direct with the manufacturers, we shall apppreciate it if you will state in your letters that you are indebted to ENGINEERING-CONTRACTING for the introduction. Such a statement will be mutually beneficial.

2 Asbestos.
4 Asphalt.
6 Asphalt plants.
7 Asphalt tools.
8 Augers, pneumatic.

10 Ballast spreaders.
12 Balast unloaders.
14 Bearing, ball and roller.
16 Bearings, self-oiling.
18 Bellows.
20 Belt dressing.
22 Belting, canvas.
24 Belting, chain.
26 Belting, leather.
28 Belting, rubber.
30 Blacksmiths' tools.
31 Blasting batteries.
32 Block machines, cement and concrete.
33 Blocks, tackle.
Blowers. See 180.
36 Blue print machines.
38 Boilers.
39 Boiler covering.
40 Brakes, air.
42 Brick, building.
44 Brick, paving.
45 Brick machines.
46 Bridges.
48 Buckets, clam shell.
50 Buckets, dumping.
52 Buckets, orange peel.

60 Cableways.
62 Cars, ballast.
64 Cars, dump.
66 Cars, flat.
68 Cars, hand.
69 Cars, mining.
70 Carts. See also 520.
72 Carts, concrete.
73 Castings, brass.
74 Castings, iron.
76 Castings, steel.
Cement block mach. See 32
80 Cement pipe molds.
82 Cement walk tools.
84 Cement, natural.
86 Cement, Portland.
88 Chains, common.
90 Chains, sprocket.
91 Channelers.
92 Clocks, time.
93 Chimney construction.
94 Compressors, air.
95 Conduit, bituminous fiber.
Concrete reinf. See 474.
Conduit, vitrified. See 142.
96 Concrete fence post molds.
97 Computing machines.
98 Contractors' bonds.
100 Contractors' supplies.
102 Conveying machinery.

104 Cranes.
106 Cranes, locomotive.
108 Cranes, traveling.
110 Creosoting.
112 Crossings, railway.
114 Crushers, rock.
116 Culverts.

120 Derricks and fittings.
Draftmen's instrs. See 154.
124 Dredges.
126 Drill sharpeners.
Drills, air. See 136.
128 Drills, core.
130 Drills, diamond.
132 Drills, pneumatic plug.
134 Drills, ratchet.
136 Drills, rock.
138 Drills, well.
140 Dynamite.
142 Ducts, vitrified.
Dump wagons. See 520.
144 Dynamos.

Electric motors. See 324.
152 Elevators, bucket.
154 Engineers' instruments.
156 Engines.
158 Engines, gas.
160 Engines, gasoline.
162 Engines, hoisting.
164 Engines, steam.
166 Engines, traction.
167 Expansion bolts.
168 Expanded metal.
169 Expanders, tube.
170 Exploders.
172 Explosives.

180 Fans or blowers.
182 Felt.
184 Fence and railing.
186 Filters, water.
187 Fireproof doors, partitions.
188 Flanges, steel.
190 Flue lining.
192 Flush tanks.
194 Forges, blacksmith.
195 Forms for concrete work.
196 Frogs.
198 Fuel economizers.
Fuse. See 170.

210 Garbage furnaces.
212 Gates and valves.
214 Gears and pinions.
216 Governors, engine.
218 Governors, water wheel.
220 Graders, elevating.
222 Gaskets.
224 Grubbers.

228 Hammers, pneumatic.
230 Hangers, joist.
232 Harness.
234 Hoists, air.
236 Hoists, chain, differential.
238 Hoists, electric.
240 Hoists, gasoline.
242 Hoists, horse-whim.
244 Hoists, steam.
246 Horse feed-bags.
248 Hose.
250 Hydrants.

260 Injectors.
261 Insulated wire.
262 Iron.
264 Iron, corrugated.
266 Iron, sheet.

270 Jacks, hydraulic.
272 Jacks, screw.
274 Jacks, track.
Jacks, trench. See 502.

280 Laborers supplied.
282 Lamp posts.
284 Lathe, metal.
286 Lights, contractors'.
288 Lime.
290 Locomotives, dinkey.
292 Locomotives, electric.
294 Locomotives, gasoline.
296 Locomotives, geared.
298 Locomotives, steam.
300 Lubricants.
302 Lumber, creosoted.

310 Machine tools.
312 Manganese steel.
314 Manhole covers.
315 Metaline.
316 Meters, water.
318 Mineral wool.
319 Mining machinery.
320 Mixers, concrete.
322 Motors, compressed air.
324 Motors, electric.
326 Motors, water.

330 Nickel steel.
332 Nuts and nut locks.

330 Oilless Bearings.

340 Packing.
341 Painting machines.
342 Paints.
344 Paving blocks, stone.
Paving bricks. See 44.
348 Picks.
350 Pile drivers.
352 Pile driver jets.
354 Piles, concrete.
356 Piles, interlocking, steel.
358 Piles, creosoted.
360 Pipe covering.
362 Pipe, cast iron.
364 Pipe, cement.
366 Pipe, lead.
368 Pipe, riveted steel.
370 Pipe, vitrified sewer.
372 Pipe, wrought iron.
374 Pipe cutting machine.
375 Pipe tapping machines.
376 Plows.
Plows, unloading. See 12.
Pneumatic tools. See 8, 132, 416.
380 Portable railways.
382 Powder, black.
383 Prism glass.
384 Pulleys.
386 Pumps, diaphragm.
388 Pumps, electric.
392 Pumps, sand.
394 Pumps, steam.
396 Pumps, trench.
398 Punches, hydraulic.

400 Quarry bars.

406 Railroad signals.
410 Rails, new.
412 Rails, second hand.
413 Railway track layers.
414 Rammers, pneumatic.
415 Recording instruments.
416 Riveters, pneumatic.
418 Road machinery.
Rock crushers. See 114.
422 Rollers, horse.
424 Rollers, steam.
425 Roofers' supplies.
426 Roofing.
427 Rope drive.
428 Rope, manila.
430 Rope, wire.

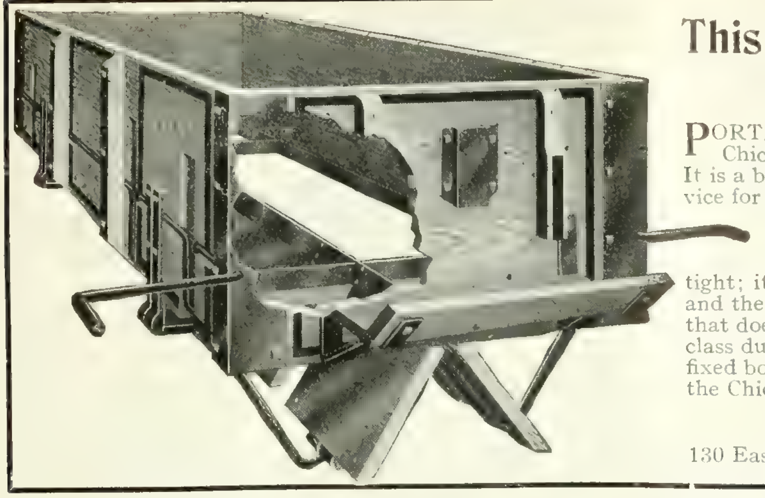
438 Sand blast apparatus.
Sand pump. See 392.
440 Saw mills, portable.
Scale box. See 462.
442 Scarifiers for macadam.
444 Scrapers, drag.
446 Scrapers, road.
Scrapers, wheel. See 528.
448 Screens, rotary.
450 Second hand outfits.
Sewer braces. See 502.
454 Sewer cleaners.
455 Sewer traps.
Sewer pipe. See pipe.
457 Shafting.
458 Sheaves.
460 Shovels, hand.
462 Skips.
464 Slate.
466 Sprinkling carts.
468 Standpipes.
470 Steam shovels.
472 Steel, structural.
474 Steel for reinf. concrete.
476 Stone, broken.
478 Stone dressing mach's.
479 Street sweepers.
480 Stump puller.
482 Switches.

490 Tanks, water.
491 Tapes, measuring.
Tapping mach's. See 375.
492 Tar.
494 Tents.
496 Ties, steel.
498 Tile.
Time keeping devices. See 92.
Traction engines. See 166.
Track laying mach. See 413.
499 Track tools.
500 Tracing cloth.
502 Trench braces.
504 Trench machines.
506 Turntables.

510 Valves, steam.
512 Valves, water.
513 Vault lights.
514 Ventilators.

520 Wagons, dump.
522 Waterproofing.
Well drills. See 138.
526 Wheelbarrows.
528 Wheel scrapers.
530 Windmills.
532 Wire cloth.
Wire rope. See 430.

The above is only a partial list of the headings in our Card Index. No matter what you want, TELL US and we will put you in prompt communication with the leading manufacturers, dealers or contractors.



This is more than a portable dumping box

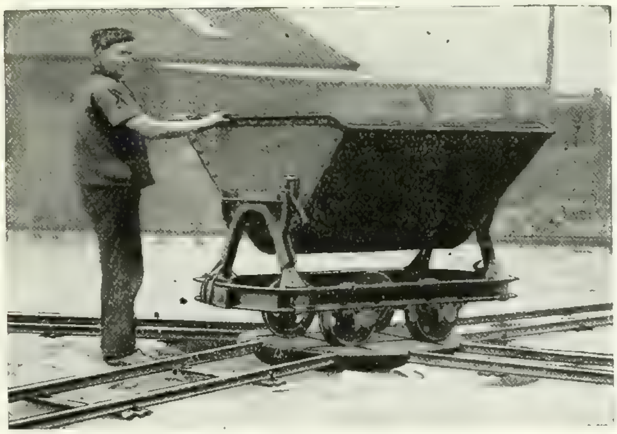
PORTABLE dumping boxes for wagons are common. The Chicago Quick Dumper is more than a portable dumping box. It is a bottom dump wagon box which by means of a special device for operating the bottom doors distributes the load equally over the front and rear wheels and allows the gear to be coupled up as close as 65 inches. Every teamster knows what this means—it means light draft. The box is sand tight; it fits any wagon gear having a reach. Take off the box and the gear is ready for hauling lumber or poles or anything else that does not need a box. Put on the box and there is a high class dumping wagon at a quarter of the cost of any ordinary fixed box dumping wagon. Our CATALOG No. 22 tells all about the Chicago Quick Dumper. **Over 600 are in use in Chicago.**

BLACK MANUFACTURING CO.
130 East Ohio Street CHICAGO

ONE CENT A WORD
is the price of an undisplayed "Want" advertisement in this paper, or $1.00 an inch if the advertisement is displayed.

The Peerless Hand Sweeper
For Sweeping Streets, Warehouses, Wharves, Etc.
J. S. BARRON,
Dept. 33, Franklin Street, and W. Broadway, New York
Eastern Agent for the Twentieth Century Grader

USE THE
"Blaw System"
for centering your concrete structures.
Write for CATALOG
BLAW COLLAPSIBLE STEEL CENTERING CO.
General Offices:
Westinghouse Building
PITTSBURG, PA.
CHICAGO OFFICE: 1005 Chamber of Commerce Bldg.
NEW YORK OFFICE: 320 Park Row Bldg.



Steel Dump Cars
4, 6 and 12 Yards

Save 50 per cent of cost in grading operations, over old style equipment. Large stock of cars, portable track, rails, switches, turn-tables, etc., always on hand.

We also have track and cars for rent.

WRITE FOR RENTING LIST E

ARTHUR KOPPEL COMPANY
OFFICES AND WAREHOUSES

NEW YORK
139 Morris Bldg.

CHICAGO
341D Monadnock Bldg.

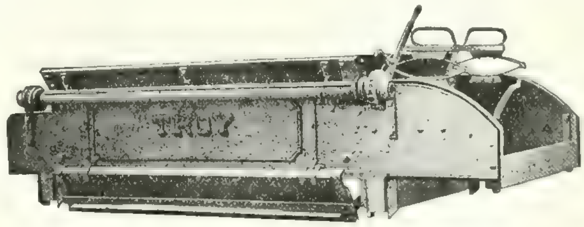
BOSTON
53 Oliver St.

PITTSBURGH
1610 Machesney Bldg.

SAN FRANCISCO
151a Chronicle Bldg.

BALTIMORE
449 Equitable Bldg.

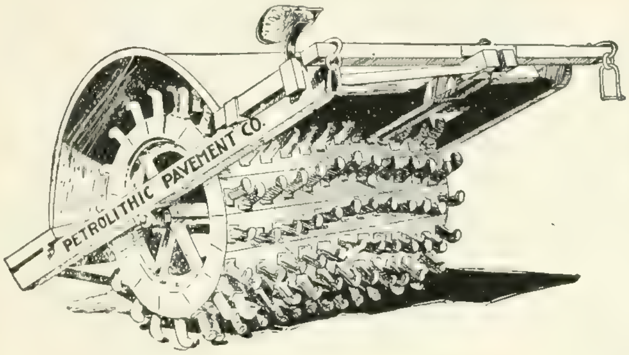
THERE are four bottom doors on a Troy Dump Wagon Box, two hinged to the outer sides of the box and two hinged to a beam that runs lengthwise of the box, directly over the "reach" of the wagon gear. By this arrangement the Troy Dump Box fits any gear. It will be noted that the same simple mechanism is used for raising these bottom doors as is used on the standard Troy Dump Wagon. No other door raising mechanism is so simple and strong. Send for BULLETIN E which describes this mechanism and gives further facts about Troy Dump Boxes.



The Troy Wagon Works Co.
295 South Walnut Street **TROY, OHIO**

The Dustless Pavement —Petrolith

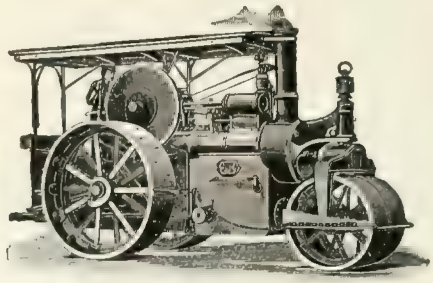
With the advent of automobiles, road and street designers have been confronted by a grave problem — the dust nuisance. Surface sprinkling and oiling has served to palliate the trouble, but can never cure the evil. An entirely new design of roadway is necessary. Petrolithic Pavement is designed to do away with the dust nuisance, and, incidentally, it has turned out to be the cheapest durable pavement ever devised. The process of making Petrolith consists in shaping the roadway, and in plowing the earth to a depth of about six inches. Then it is sprinkled with asphaltic oil or with any bituminous or tarry product suitable for the purpose. The soil and the oil are next mixed with a farm cultivator and then tamped with a Petrolithic Rolling Tamper. Oiling, harrowing and tamping are repeated until a pavement is produced that is almost as dense as an asphalt pavement, but free from dust and noiseless. It is ideal for residence streets and country roads, but has also been extensively used on business streets. Our large catalog illustrates numerous streets and roads and gives details of construction.


PETROLITHIC PAVEMENT CO.

Petrolithic Pavement Company

764 Pacific Electric Bldg., Los Angeles, Cal.

KELLY-SPRINGFIELD ROAD ROLLER CO.



Steam Road Rollers, Over Eighteen Hundred in Use. All Types, All Sizes, Satisfaction Guaranteed. Send for Catalogue No. 4

SPRINGFIELD, O.

PHILADELPHIA OFFICE, 2132 LAND TITLE BUILDING

"NEW YORK" STEAM ROLLERS

Have Double Engines, Two Speeds, Differential Gear, Steam Dome

THE "NEW YORK" SCARIFIERS

have double-pointed picks

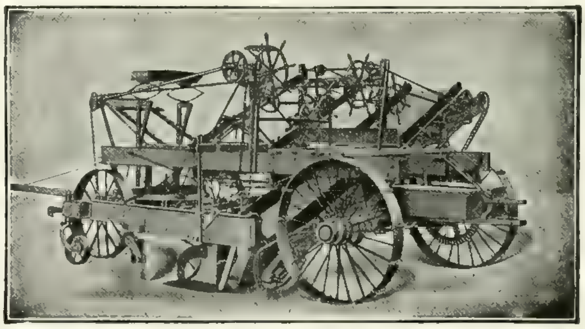
ETNYRE SPRINKLING WAGONS

WRITE FOR CATALOGS

CHARLES LONGENECKER & COMPANY

150 Nassau Street, NEW YORK, U. S. A.

NATIONAL ELEVATING GRADER



Send for Catalogue EC

INDIANA ROAD MACHINE COMPANY

FORT WAYNE, IND.

Remodeled, Handsomely Furnished New Throughout

THE ALBANY

41st Street and Broadway
NEW YORK

ABSOLUTELY FIREPROOF

In the heart of the City

500 Rooms **300 Bath Rooms**

European Plan. Cuisine Unexcelled. Gentlemen's Cafe. Ladies' Restaurant and Moorish Rooms. Popular Prices. Plenty of life—but home-like. Single Room and Suites with and without Bath.

$1.00 per Day and up

Send for Booklet

ROBERT P. MURPHY

Some Advantages of

Creosoted Wood Paving Blocks

Smooth as Asphalt.

Durable as Granite Blocks.

Sanitary on Account of antiseptic treatment.

Noiseless to a greater extent than any other pavement.

Appeals to tax payers and contractors alike.

Capacity 3,000,000 yards a year.

Ayer & Lord Tie Company
1123—138 Washington Street
CHICAGO, ILL.

FRANK C. POWERS, Sales Agent

THE TRUTH ABOUT STREET PAVING

generally comes out **after** the pavement has been laid and when it is too late to remedy the mistake.

When Bitulithic is selected and laid no mistake is made. The truth about street paving is then so fully, clearly and convincingly laid bare that there is no longer room for doubt as to the ideal roadway.

WRITE FOR ILLUSTRATED BOOKLETS.

WARREN BROTHERS COMPANY
BOSTON, MASSACHUSETTS

Registered Trade Marks: "Bitulithic" "Puritan" "Bituminous Macadam" "Bitrock" "Bitustone"

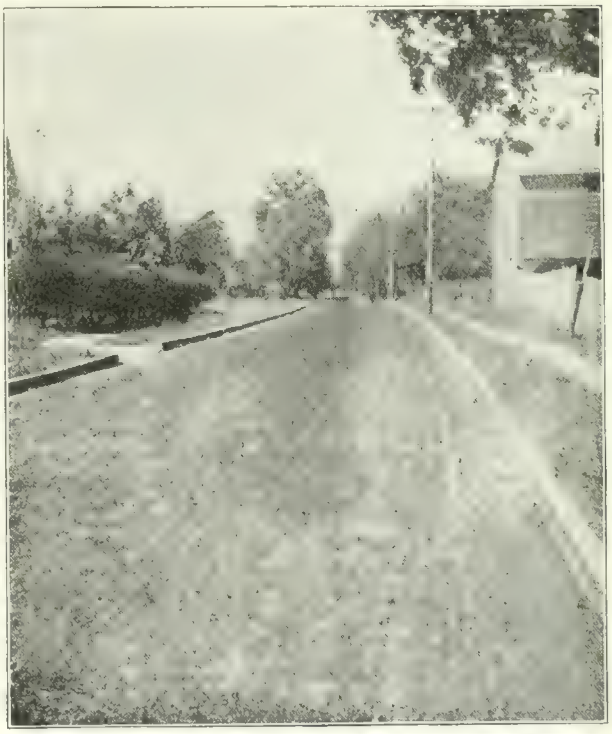
GULF REFINING CO.

REFINER OF

Indian Territory and Texas Petroleum

MANUFACTURER OF

ASPHALT for PAVING and ROOFING



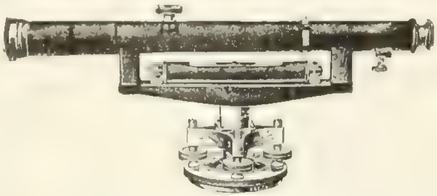
A Resurfaced Macadam Road after Oiling, at Delmar, N. Y.

WE MAKE A SPECIALTY OF

Heavy Oil of Asphaltum Base For Oiling Roads

Prompt shipments from Boston, New York, Philadelphia, New Orleans, Tampa, Fla., and Port Arthur, Texas.

**General Offices: Frick Building Annex,
PITTSBURG, PENNSYLVANIA.**



ENGINEER'S DUMPY LEVEL

FOR QUICK, ACCURATE WORK
FOR WORK ON ROUGH GROUND

A thoroughly reliable and accurate level of the finest workmanship. Erecting Telescope 18 inches, fine sensitive spirit level graduated on the glass, eyepiece adjustable vertically with patent Micrometer Focusing Arrangement with lock nut. Four Leveling Screws. Telescope bar and tube of spirit level cloth finish. The center is of the K & E Patent Construction. Split Tripod.

Our complete Catalog and Our Solar Ephemeris for 1908 (pocket size) Free on request.

127 Fulton Street,
NEW YORK

KEUFFEL & ESSER CO.,

General Office and Factories
HOBOKEN, N. J.

CHICAGO—ST. LOUIS—SAN FRANCISCO

Drawing Materials Mathematical and Surveying Instruments Measuring Tapes

F. D. CROFOOT N. NIELSEN

Printing by Electric Light

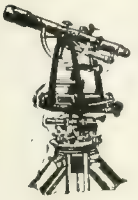
Crofoot, Nielsen & Company

BLUE PRINTERS

Blue Printing, Black Printing **Blue Line and Color Printing**

Special Service Always—Speed and RESULTS. Big Floor Space and Equipment for Rush Orders.

167-169 E. Washington Street, CHICAGO
Phone 759 Main

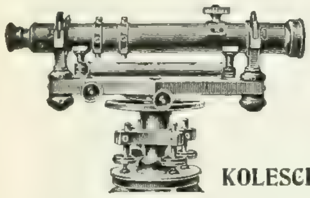


BUFF SURVEYING INSTRUMENTS

Our Mr. Geo. L. Buff, years ago, made whole transits by contract for Stackpole & Son, who, in 1860 to 1870, held the record for the best.

Send for Catalog No. 3

BUFF & BUFF COMPANY, Boston, Mass.



IS IT LEVEL?

The use of an Architect's Level assures you of correct results and saves time.
Our catalogue describes this and other useful instruments.

KOLESCH & CO., 142 Fulton St., New York

R. SEELIG & SON

172 E. MADISON ST., CHICAGO

MANUFACTURERS OF MOST IMPROVED

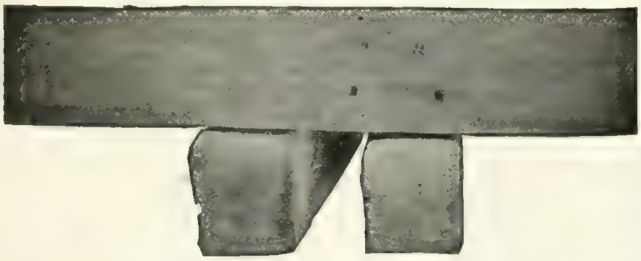
ENGINEERING and SURVEYING INSTRUMENTS

Send for Catalog No. 6.

15 Mins. in Hot Paint Gives Life of 15 Yrs.

This photograph shows railroad ties of southern pine that were immersed 15 minutes in hot paint made by this company. After nine years service the ties are as sound as the day they were treated, which means that, at worst, they will have a life of not less than 15 years. The paint contains a germicide that is death not only to the fungus of rot but to teredos and all forms of timber parasites. No engineer who is concerned with the preservation of ties, piles, fences, telegraph and telephone poles, or bridge timbers, can offord not to send for our catalog at once and investigate this paint.

The Teredo-Proof Paint Company
17 Battery Place, New York



U. S. or CANADIAN PATENTS $25.00

We pay all expenses and disbursements except government fees.

Write to us for preliminary opinions on all legal matters. No charge unless retained.

Associates throughout Continental Europe, Great Britain, the Colonies, South America and Canada enable us to investigate and prosecute foreign interests with dispatch.

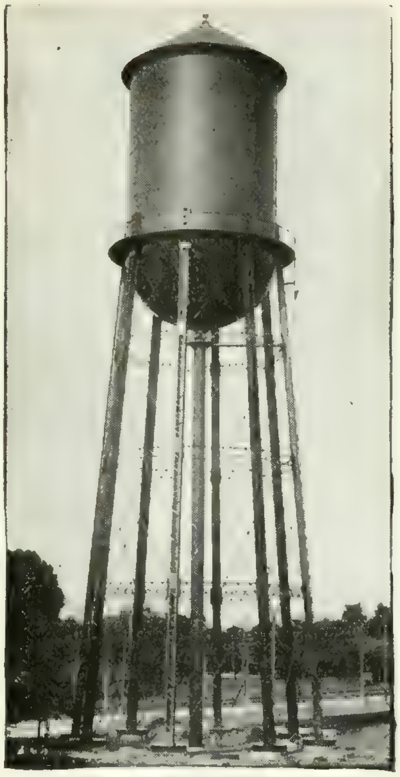
Our Pamphlet for the Asking.

The Industrial Law League, Inc.
170 Broadway, New York City, N. Y.

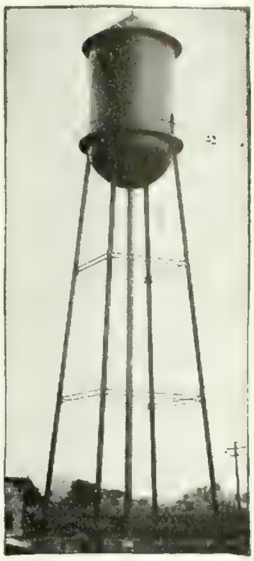
One Way to Save Money

If you are interested in the construction or operation of municipal water works, you can save money for the city by constructing an elevated tank on the system. This will give a uniform static pressure of any amount desired upon the mains, and cause a saving in cost of pumping which will pay for the structure in a very short time, besides affording fire protection which is independent of the operation of pumps for several hours. These illustrations show some of the tanks we have built for this purpose. The cuts are all made to the same scale and give some idea of their comparative sizes, the Louisville tank being the largest in the world. Write for illustrated booklet.

Chicago Bridge and Iron Works
Washington Heights Sta., Chicago.



Capacity 1,200,000 Gals.
Height 220 ft.
Louisville, Ky.
Louisville Water Co.



Capacity 200,000 Gals.
Height 157 ft.
Sycamore, Ill.
City Water Works

Cap'y 40,000 Gals.
Height 98 ft.
Greeley, Neb.
City Water Works

Cap'y 2,000 Gals.
Height 42 ft.
Belton, S. C.
Private Res.

Cap'y 60,000 Gals.
Height 85 ft.
Lock Haven, Ill.
C. P. & St. L. Ry.

McWANE-LYNCHBURG TRADE CAST IRON PIPE MARK "QUALITY BEFORE QUANTITY"

WATER AND GAS WORKS MANAGERS

WRITE FOR CATALOG OF

McWANE PIPE WORKS
LYNCHBURG, VA. NEW YORK CITY

TELL US YOUR WANTS

If you desire information concerning any tools, supplies or machinery, or books on any subject. If you are in the market for **anything** send us a postal card and we will notify the leading dealers or manufacturers. No matter what it is, **tell us.**
ENGINEERING-CONTRACTING, 335 Dearborn St., Chicago.

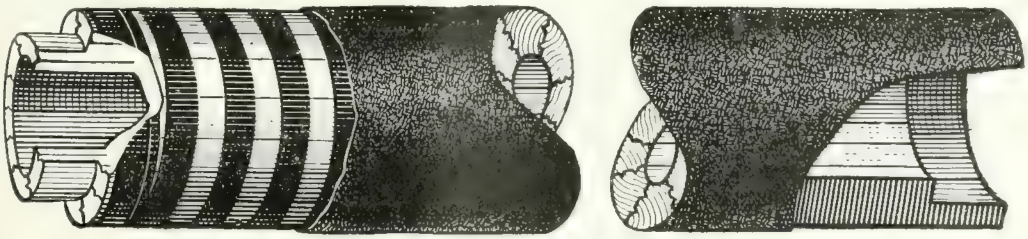
Mechanical Filtration

Holyoke Fire Hydrants
Write for Catalog or Further Information
NORWOOD ENGINEERING CO.
FLORENCE, MASS.

Improved Combination Steel and Wood Pipe

For Municipal Water-Works Systems, Mines, Railroads, Chemical and Iron Works

Strength of Steel
Will Not Rust
Easily Installed



Durable
Cheaper Than Iron Pipe
Keeps Water Conveyed Sweet

WRITE FOR CIRCULARS

THE MICHIGAN PIPE COMPANY, BAY CITY, MICHIGAN

CLASSIFIED DIRECTORY OF ADVERTISERS—(For location of advertisements see Alphabetical Index, page 8).

Air Compressors
American Well Works.
Ingersoll-Rand Co.

Architects' Supplies (See Engineers' Supplies, Instruments etc.)

Artesian Wells, Tools, Pumps
American Well Works.
Cook Well Co.

Asphalt
Barrett Mfg. Co.
Gulf Refining Co.
Standard Asphalt & Rubber Co.
Warren Bros. Co.

Automatic Stokers (See Grates, Traveling Link)

Ballast Unloaders and Spreader
Browning Engineering Co.
Marion Steam Shovel Co.

Bearings—Oilless and Self-Oiling
North Am. Metaline Co.

Blocks—Snatch and Tackle
Chisholm & Moore Mfg. Co.
Patterson Co., W. W.
Union Elevator & Machine Co.

Block Machines (See Concrete Block Machines)

Blue Print Apparatus and Paper
Am. Blue Print Paper Co.
Crofoot, Nielsen & Co.
Fritz & Goeldel Mfg. Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.
Technical Supply Co.

Bolts
Scovil Mfg. & Supply Co.

Books
Audel & Co., Theo.
Clark Pub. Co., Myron C.
Engineering News Book Dept.
Nash, A. L.
Technical Supply Co.

Boots for Contractors
Rubberhide Co.

Borings—Test (See Artesian Wells)

Bridges, Roofs, Trusses, Etc.
Chicago Bridge & Iron Wks.
Continental Bridge Co.
Page & Shnable.
Ransome Concrete Machy. Co.

Buckets—Coal, Ore, Dredging
Chandler, Geo. M.
Channon Co., H.
Cyclopean Iron Works.
Hayward Co.
Hough Co., Wm. B.
Kiesler Co.
Northern Engineering Works.
Page & Shnable.
Sackett Screen & Chute Co.
Tide Water Iron Works.
Wiener Co., Ernst.
Williams Co., G. H.

Cableways — Suspension Wire Rope
Balanced Cable Crane Co.
Flory Mfg. Co., S.
Harper Machinery Co.

Car Couplers, Fenders, Fittings, Car Wheels
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Cars
Contin'tl Car & Equip't Co.
Harper Machinery Co.
Hicks Locomotive & Car Wks.
Hough Co., Wm. B.
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Weiner Co., Ernst.

Carts for Concrete, Etc.
Archer Iron Works.
Hough Co., Wm. B.
Ransome Concrete Machy. Co.
Sackett Screen & Chute Co.

Carts and Wagons — Ash and Dump
Black Mfg. Co.
Contractors' Sup. & Equip. Co.
Good Roads Machinery Co.
Hough Co., Wm. B.
Indiana Road Machy. Co.
Ransome Concrete Mach. Co.
Sackett Screen & Chute Co.
Studebaker Bros. Mfg. Co.
Troy Wagon Works Co.

Castings and Forging
American Casting Co.
Green Engineering Co.
Scovil Mfg. & Supply Co.
Tide Water Iron Works.
Vulcan Iron Works.

Cement
Atlas Portland Cement Co.
Chicago Portland Cement Co.
Edison Portland Cement Co.
Lehigh Portland Cement Co.
Marquette Cement Mfg. Co.
Universal Portland Cement Co.

Chains
Hayden-Corbett Chain Co.
Woodhouse Chain Works.

Chain Belts—(See Power Transmission Machinery)

Chimney—Iron and Steel—(See Boilers

Clocks
Prentiss Clock Co.

Coal and Ore Handling and Conveying Machinery, Etc.
Browning Engineering Co.
Brown Hoisting Machy. Co.
Channon Co., H.
Hayward Co.
Hough Co., Wm. B.
Koppel Co., Arthur.
Northern Engineering Works.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Collapsible Centerings
Blaw Steel Centering Co.

Concrete Made Refractory
Stowell, E. R.

Concrete Mixers and Machinery —(See Mixers—Concrete)

Concrete Work—(See Contractors; also Fireproof Construction)

Consulting Forester
Meier, F. R.

Contractors
Caton & Olmstead.
Continental Bridge Co.
Gilbreth, Frank B.
Jackson, Inc., Geo. W.
McGrath, M. P.
Rodgers Co.
Trussed Concrete Steel Co.

Contractors' Supplies and Equipment — (See also Second-hand Supplies)
Archer Iron Works.
Chandler, Geo. M.
Channon Co., H.
Contractors' Sup. & Equip. Co.
Harper Machinery Co.
Hough Co., Wm. B.
Koppel Co., Arthur.
Lucas & Co., R. G.
Sackett Screen & Chute Co.
Scovil Mfg. & Supply Co.
Torbert & Co., A. C.
Union Eltr. & Mach. Co.
U. S. Equipment Co.
Wiener Co., Ernst.

Conveyors and Conveying Machinery—(See Coal and Ore Handling and Conveying Machinery)

Correspondence Courses in Engineering
Concrete Engineering.

Couplings—Friction Clutch
Brown Hoisting Machy. Co.
Browning Engineering Co.
Sackett Screen & Chute Co.

Cranes
Brown Hoisting Machy. Co.
Browning Engineering Co.
Northern Engineering Works.

Crayons and Pencils—(See Engineers' Supplies)

Creosoting
Ayer & Lord Tie Co.

Crossings—Railways (See Frogs)

Crushers and Pulverizers
Chicago Concrete Mchy. Co.
Good Roads Machinery Co.

Culverts
American Rolling Mill Co.
Crawfordsville Corrugated Culvert Co.

Derricks and Derrick Fittings
Browning Engineering Co.
Carson Trench Machine Co.
Contractors' Sup. & Equip. Co.
Flory Mfg. Co., S.
Hough Co., Wm. B.
Northern Engineering Works.
Parker Hoist & Machine Co.
Terry & Tench Co.

Ditching Machinery, Steam Shovels, Etc.
Austin Drainage Excavator Co
Atlantic Equipment Co.
Brown Hoisting Mach. Co.
Browning Machinery Co.
Buckeye Traction Ditcher Co.
Carson Trench Machine Co.
Ellicott Machine Co.
Fairbanks Steam Shovel Co.
Flory Manufacturing Co.
Harper Machinery Co.
Hayward Co.
Hough Co., Wm. B.
Ingersoll-Rand Co.
Marion Steam Shovel Co.
Municipal Eng. & Contrg. Co.
Parsons Co., G. W.
St. Paul Ditcher & Carrier Co.
Souther & Co., John.
Thew Automatic Shovel Co.
Torbert & Co., A. C.
Vulcan Iron Works.
Vulcan Steam Shovel Co.

Drafting Room Furniture (See also Engineers' Supplies)
Berger Mfg. Co.
Fritz & Goeldel Mfg. Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.

Dredging Machinery (See also Ditching Machinery)
Ellicott Machine Co.

Drills—Core, Prospecting
American Well Works.
Cyclone Drill Co.

Drills—Rock and Ore
Cyclone Drill Co.
Ingersoll-Rand Co.
Wood Drill Works.

Dump Wagons (See Carts and Wagons

Dust Collectors
Knickerbocker Co.

Dynamometers
Du Vivier, E. H.

Employment Agencies
Assoc. Union of S. S. & D. Engineering Agency.
Graham, J. F.
Hapgoods.
Int. Bro. of S. S. & D'men.

Engineers—Civil, Consulting and Mechanical—(See Engineers' Directory)

Engineers' Supplies, Instruments, Etc.
Am. Blue Print Paper Co.
Buff & Buff Co.
Crofoot, Nielson & Co.
Keuffel & Esser Co.
Kolesch & Co.
Prince, L. M.
Ruehle & Co., E. G.
Seelig & Son, R.
Young & Sons.

Engines—Gas, Gasoline and Oil
American Well Works.

Engines—Hoisting
Brown Hoisting Mach. Co.
Channon Co., H.
Flory Mfg. Co., S.
Harper Machinery Co.
Hough Co., Wm. B.
Northern Engineering Works.
Stroudsburg Engine Works.

Engines—Stationary and Pumping
American Well Works.
Channon Co., H.
Cook Well Co.
Erie Pump & Engine Co.
Harper Machinery Co.
Hough Co., Wm. B.
Stroudsburg Engine Works.

Engines—Traction
Harper Machinery Co.

Expanded Metal—(See Fireproof Construction)

Excavating Machinery — (See Ditching Machinery)

Fence and Railing
Anchor Post Iron Works.

Fence Posts—Iron
Anchor Post Iron Works.

Filing Cases (See Drafting Room Furniture)

Filters—Water
New York Continental Jewell Filtration Co.
Norwood Engineering Co.

Fireproof Construction
Berger Mfg. Co.
Calumet Steel Co.
Concrete Column & Const. Co.
Hough Co., Wm. B.
Ransome Concrete Mach. Co.
Rodgers Co.
Trussed Concrete Steel Co.

Forms for Concrete Work.
Dietrichs Co., Charles.
Sullivan, J. H.

Frogs, Crossings and Switches —Railway
Cincinnati Frog & Switch Co.
Indianapolis Switch & Frog Co.
Koppel Co., Arthur.
Weiner Co., Ernst.

Furniture and Office Fittings—(See also Drafting Room Furniture)
Berger Mfg. Co.
Keuffel & Esser Co.

Gauges—Recording
Du Vivier, E. H.

Graders and Scrapers — Earth (See Road Machinery)

Grates—Traveling Link
Green Engineering Co.

Grout Mixer and Injector
Tide Water Iron Works.

Hoists
Hayward Co.
Hough Co., Wm. B.
Ingersoll-Rand Co.
Ransome Concrete Machy. Co.

Hoists—Electric
Grable-Dunn Co.
Northern Engineering Works.

Hoists—High Speed Chain
Chisholm & Moore Mfg. Co.

Hose and Fittings
Ingersoll-Rand Co.

Hydrants
Norwood Engineering Co.

Industrial Railways
Cincinnati Frog & Switch Co.
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Inspection of Iron and Steel
Am. Bureau of Insp'n & Tests.
Conard, W. R.

Insulating Materials
Barrett Mfg. Co.
Standard Asphalt & Rubber Co.

Iron and Steel Work
Chicago Bridge & Iron Works.
Continental Bridge Co.
Jackson, Inc., George W.

Iron—Sheet and Ingot
American Rolling Mill Co.

Laborers Furnished—(See Employment Agencies)

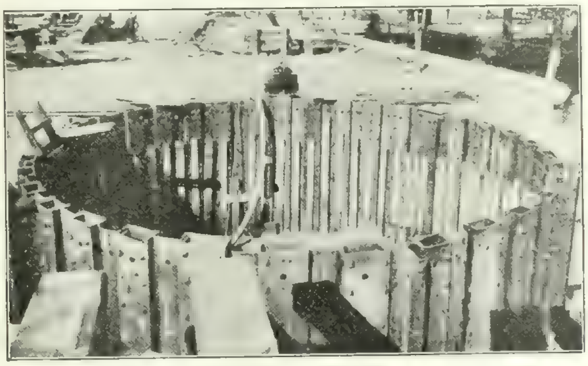
Telephone Monroe 3400, Automatic 3119

CHICAGO **George W. Jackson, Inc.** NEW YORK

169-179 W. Jackson Boulevard and 178-190 Quincy Street, Chicago

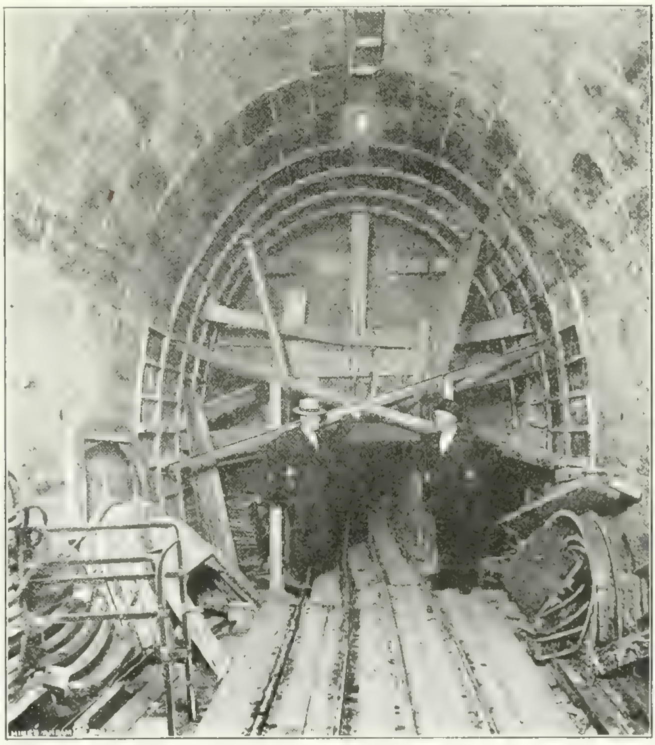
Steel Works and Plant: 80-98 Mende St. and 804-806 Elston Ave.

New York Office, 46 Wall Street



THIS picture shows the steel sheeting lining for one of the shafts of the Southwest Land Tunnel now being built by us for the additional water supply of the city of Chicago. This shaft is 22 feet in diameter and 140 feet deep and was lined with successive 50 foot lengths of steel sheeting driven ahead of the excavation. The sheeting then served as a cofferdam for excavation as well as a permanent lining for the finished shaft. Our alternate I-beam and channel style of water tight sheeting arranged as shown in the right hand border of this page was used. The shaft is absolutely dry.

THIS picture shows the use of our steel center for concrete tunnel lining as it was employed in the 14x16 foot trunk line tunnel for the Chicago Subway System. These centers consist of steel ribs carrying steel channel lagging, and we have used them continuously in our tunnel work for over seven years. They are among the most practical and economical devices ever employed in tunnel work. Their durability is testified to by the fact that we still have in use the same lagging that we first used seven years ago.



Our catalogs give you all the details of our steel sheeting and our steel tunnel centering—SEND FOR THEM

ALPHABETICAL INDEX TO ADVERTISEMENTS.

For Classified Index See Page 46.

Page
Acme Asphalt Roofing Co ... *40
Albank Hotel ... 35
Alvord, John W ... 16
Alsens American Portland Cement Works ... *29
American Blue Print Paper Co ... †30
Am Bureau of Inspection and Tests ... 16
American Casting Co ... 10
American Locomotive Co ... 31
American Mfg. Co ... 18
American Rolling Mill Co ... *18
American School of Correspondence ...
Am. Society of Engineering Contractors ... 6
American Steel & Wire Co ... 2
American Well Works ... 41
Anchor Post Iron Works ... 48
Archer Iron Works ... *43
Arnold Co. ... 16
Assoc. Union of S. S. & Dredgemen ... †45
Atlantic Equipment Co ... 12
Atlas Portland Cement Co ... 45
Audel & Co., Theo ... †xlix
Austin Drainage Excavator Co., F. C ... 32
Ayer & Lord Tie Co ... 39

Baker Mfg. Co ... *35
Balanced Cable Crane Co ... 15
Barrett Mfg. Co ... †41
Barron, J. S ... 56
Berger Mfg. Co ... *34
Black Manufacturing Co ... 37
Blaw Collapsible Steel Centering Co ... 35
Block-Pollak Iron Co ... 30
Broadway Central Hotel ... 36
Brown Hoisting Machinery Co ... 15
Browning Engineering Co ... 10
Buckeye Traction Ditcher Co ... *35
Buff and Buff Co ... 38

Calumet Steel Co ... *49
Carson Trench Machine Co ... *29
Caton & Olmsted ... 56
Challenge Co. ...
Chandler, Geo. M ... 10
Channon Co., H ... 10
Chemical Engineer ... 49
Chicago Bridge & Iron Works ... 41
Chicago Concrete Machinery Co ... *50
Chicago Portland Cement Co ... 45
Chicago Steel Tape Co ... †31
Chisholm & Moore Mfg. Co ... †2
Cincinnati Frog & Switch Co ... 31
Collins, F. W ... 16
Compressed Air ... †54
Concrete Column & Construction Co ... †59
Concrete Engineering ... 30
Conard, W. R ... 16
Continental Bridge Co ... *56
Continental Car & Equipment Co ... 31
Contractors' Supplies, List of ... 42
Contractors' Supply & Equipment Co ... 53
Cook Well Co ... †50
Cornwall, Plock & Saltzman ... 16
Corrugated Pile Company of Am ... †4, †5
Cottingham, Charles ... 16
Crane, C. A ... 16
Crofoot, Nielson & Co ... 38
Crum, E. C ... *16
Cyclone Drill Co ... *8
Cyclopean Iron Works Co ... 9

Davenport Locomotive Works ... 31
Davis, C. S. ... 16
De Young & Sons, T ... 30
Dietrichs Clamp Co ... 56
Dodge & Day ... †32
Dunning, W. D ... *52
Du Vivier, E. H ... 56

Edison Portland Cement Co ... 45
Edson Mfg. Co ... 27
Egleston Howard ... 16
Ellicott Machine Co ... 11

Page
Engineering Agency ... †44
Engineers' Directory ... 16, 17
Erie Pump & Engine Co ... 40
Engineering News ... xlii, xlv, xlvii

Fairbanks Steam Shovel Co ... 11
Field, Fellows & Hinderlider ... 16
Flory Mfg. Co., S ... †16
Foote Concrete Machinery Co ... 51
For Sale Advertisements ... 29, 31
Fritz & Goeldel Mfg. Co ... †31

Gilbreth, Frank B ... *4, *5
Golden-Anderson Valve Specialty Co ... 18
Good Roads Machinery Co ... 9
Graham, J. C ... 30
Grable-Dunn Co. ... 56
Green Engineering Co ... 56
Gulf Refining Co ... 39

Hains Concrete Mixer Co ... 52
Hamilton Mfg. Co ... †31
Hapgoods ... 30
Harper Machinery Co ... 30
Hayden-Corbett Chain Co ... *12
Hayward Co., The ... 11
Hering & Fuller ... 16
Hermitage, The ... 50
Hicks Locomotive & Car Works ... 31
Hogg, J. B ... 16
Holman Railway Tracklayer Co., D. F ... *31
Hough Co., Wm. B ... 48
Howard, J. W ... 16
Huston, Richard C ... 16

Illinois Central Railroad ... *43
Indiana Road Machine Co ... 36
Indianapolis Switch & Frog Co ... 31
Industrial Law League ... 38
Ingersoll-Rand Co. ... *3
Insley Iron Works ... 10
International Brotherhood of Steam Shovel & Dredge Men ... †45

Jackson, Granbery ... 16
Jackson, Inc., Geo. W ... 7
Johnson, E. E ... 25
Journal Western Soc. Engineers ... *12

Kalamazoo Foundry & Machine Co ... 25
Kelly-Springfield Road Roller Co ... 36
Keuffel & Esser Co ... 38
Kiesler Co. ... *10
Kirchoffer, W. G ... 16
Knickerbocker Co. ... 52
Koehring Machine Co ... 51
Kolesch & Co ... 38
Koppel Co., Arthur ... 43

Lambert, Geo. F ... *34
Lehigh Portland Cement Co ... 45
Lenox Hotel ... †50
Link Chain Belt Co ... 50
Longenecker & Co., Chas ... 36
Lucas & Co., R. C ... 30

Macleod & Co., Walter ... †42
Marion Steam Shovel Co ... 9
Marquette Cement Mfg. Co ... 56
Mayer C. ... 16
McCord, James B ... 16
McGrath, M. P ... *52
McWane Pipe Works ... 40
Meade Testing Laboratories ... 16
Meier F. R ... 25
Merrill Bros. ... 56
Michigan Pipe Co ... 40
Milburn Co., Alexander ... *18
Millard, Wm. J ... 16

Page
Mollan, E. H ... 16
Municipal Eng. & Contracting Co ... 33, 54

Nash, A. L ... 25
National Waterproofing Co ... *56
New Northern Baths and Hotel ... *50
N. Y. Continental Jewell Filtration Co ... 25
North American Metaline Co ... 56
Northern Engineering Works ... 56
Norwich University ... 30
Norwood Engineering Co ... 56

Page & Shnable ... 9
Parker Hoist & Machine Co ...
Parsons Co., Geo. W ... *34
Patterson Co., W. W ... *18
Petrolithic Pavement Co ... 37
Phillips, Hiram ... 16
Potter, Alexander ... 16
Prentiss Clock Co ... †44
Prince, L. M ... †42
Proposals ... 25-29

Ransome Concrete Machinery Co ... 55
Randolph, Isham ... 16
Reinforced Concrete Pipe Co ... †34
Richards, J. T ... 16
Ritter & Mott ... †32
Rodgers Co., The ...
Rubberhide Co. ... *26
Ruehle & Co., E. G ... †31

Sackett Screen & Chute Co., H. B ... *43
St. Paul Ditcher & Carrier Co ... *34
Scovil Manufacturing & Supply Co ... 25
Seelig, R. & Son ... 38
Shaw, E. L ... 16
Shields, W. S ... *16
Souther & Co., John ... *9
Southern Iron & Equipment Co ... 31
Standard Asphalt & Rubber Co ... *40
Standard Scale & Supply Co ... †45, †62
Stebbings, W. L ... 16
Stowell, E. R ... †54
Stroudsburg Engine Works ... 13
Studebaker Bros. Mfg. Co ... †26
Sullivan, J. H ... *56
Svenson-Shuman Machine Co ... 51

Technical Supply Co ... *38
Technical Supply Co ... *30
Teredo-Proof Paint Co ... 36
Terry & Tench Co ... 12
Thew Automatic Shovel Co ... 13
Tide Water Iron Works ... 13
Torbert & Co., A. C ... 31
Troy Wagon Works Company ... 36
Truesdell W. E ... 16
Trussed Concrete Steel Co ... 49

Union Elevator & Machine Co ... 18
Universal Portland Cement Co ... 45
U. S. Equipment Co ... 29
U. S. Wind Engine & Pump Co ... †50

Vulcan Iron Works ... 29
Vulcan Steam Shovel Co ... *10

Wants ... 30
Warren Brothers Co ... 39
Wemlinger Steel Piling Co ... 1
White & Co., J. G., Incorporated ... 17
Wiener Co., Ernst ... *18
Williams Co., G. H ... 10
Wood Drill Works ... *3
Woodhouse Chain Works ... 12

Young & Sons ... 25
Young, W. W ... 16

Zelnicker Supply Co., W. A ... 31

*Every other week. †Once a month (first issue in month).

1353 Feet 3-inch Hole in 259 Hours?

Material Hard Basalt Rock. Average Record being made on Lorimer & Gallagher's work, Ellensburg, Washington.

1095 Feet 3-inch Hole in 274 Hours

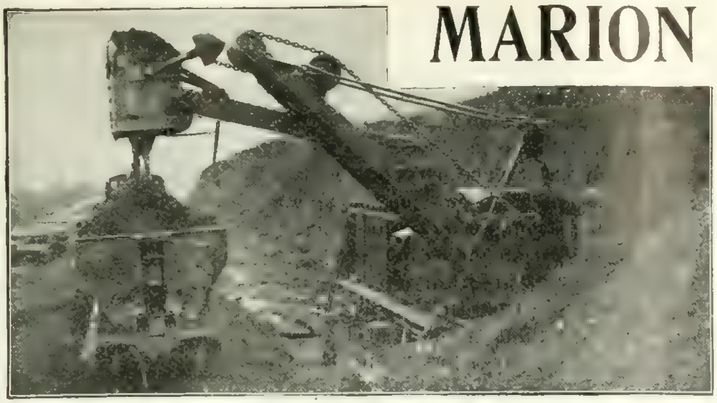
Material, principally all Limestone. Work on Kentucky & Tennessee R. R. These are just AVERAGE RECORDS being made with CYCLONE SPECIAL CONTRACTORS' ROD DRILLS on Railroad and Quarry work.

Let us send you complete catalogs and full information regarding our BLAST HOLE DRILLS and LOADERS.

SEND FOR OUR SPECIAL CONTRACTORS' CATALOG AND COST BOOK.

The Jan.-Feb.-April issues of "The Drill Hole" contains detailed records of the above. SEND FOR THEM.

THE CYCLONE DRILL CO.
ORRVILLE, OHIO



Marion Model "91" Shovel

MARION STEAM SHOVELS

All sizes, either railroad or traction. Ballast Unloaders, Dredgers and Ditching Machinery. We have the largest and best equipped plant in the world for the manufacture of this class of machinery.

The Marion Steam Shovel Co.
No. 630 W. Center St., Marion, O.

G. W. BARNHART, W. Mgr.
718 Monadnock Bldg., San Francisco, Cal.
F. H. HOPKINS & CO. Agts.
Montreal, P. Q.

CYCLOPEAN Bottom Dumping **BUCKETS**

have no equal for handling Concrete, Excavations etc.
Shipments from stock. Send for catalog E-C.

The Cyclopean Iron Works Co., 402-404 Claremont Av.
JERSEY CITY, N. J.

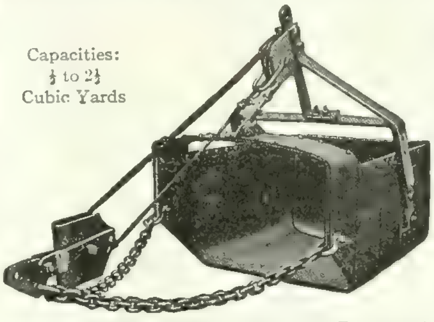
Telephone 880 Cortland

THE GOOD ROADS MACHINERY CO.
114 Liberty Street, NEW YORK

Champion Rock Crushers, Road Machines and Road Rollers.
National Dump Wagons and Elevating Graders.
Pennock Iron Bending Machines. Contractors' Machinery.

The Page Patented Bucket

Capacities:
$\frac{1}{2}$ to $2\frac{1}{2}$
Cubic Yards



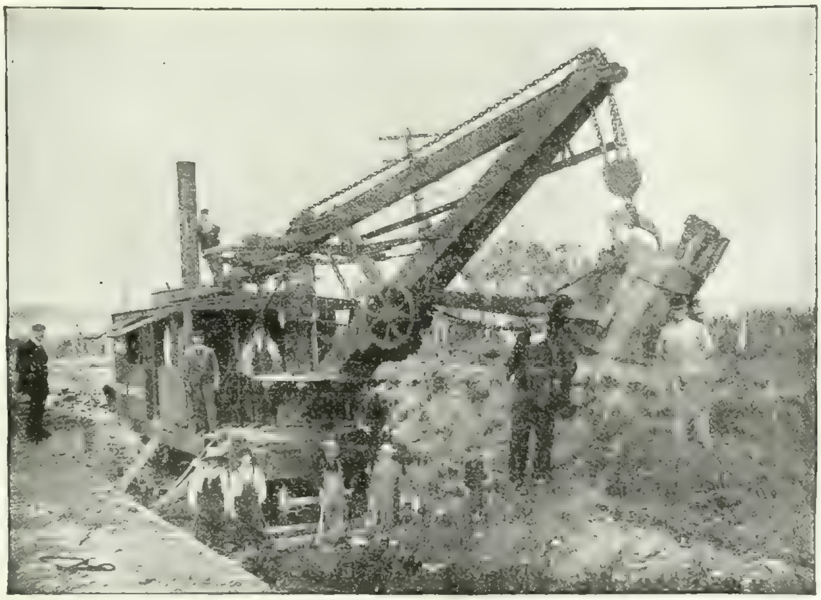
The Latest Successful
Two-Line

AUTOMATIC-
DUMPING-
SELF-LOADING
POWER-SCRAPER

Manufactured by

PAGE & SHNABLE, General Contractors
1002 Security Building CHICAGO

STEAM SHOVELS



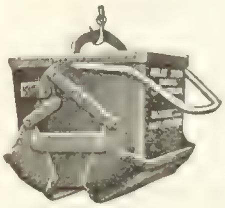
Standard
Gauge
and
Others

JOHN SOUTHER & CO.
Brown Building
BOSTON, MASS.

Send for Catalogue

"We handled with one of your 2 yard shovels, some 800,000 yards of stiff clay in two years, a part of the time working night as well as daytime. We had no serious breakdowns and the shovel after handling this amount was as efficient as at the start. The machine takes very little coal, not more than half a ton a day." JAMES E. CHAPMAN, Contractor.

CONTROLLABLE CENTER DUMP BUCKETS



PATENTED

MANUFACTURED BY

THE INSLEY IRON WORKS

INDIANAPOLIS, INDIANA

FOR INFORMATION AND PRICES ADDRESS

GEO. M. CHANDLER, Gen'l Sales Agent
31 CLAYPOOL BUILDING, INDIANAPOLIS, INDIANA

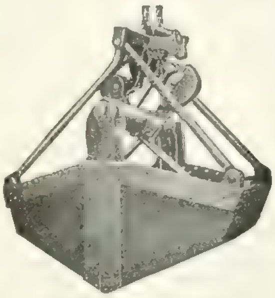
This Revolving Steam Shovel

can also be used as a LOCOMOTIVE CRANE for handling a *Clam Shell or Orange Peel Bucket or Hook Block*. It is also designed to work on top of flat cars with *Dipper, Bucket or Hook*, and all operations are controlled by one man. Will excavate at cost of 5 cents per cubic yard. Capacities with ¾- to 1½-yard dipper, 200 to 600 yards per day.

Postal or telegram at our expense will bring further information regarding a machine for quick delivery.

The Browning Engineering Co., Cleveland, Ohio

KIESLER BEST BY TEST BUCKETS



SEND FOR CATALOG

Clam Shell and Orange Peel Type

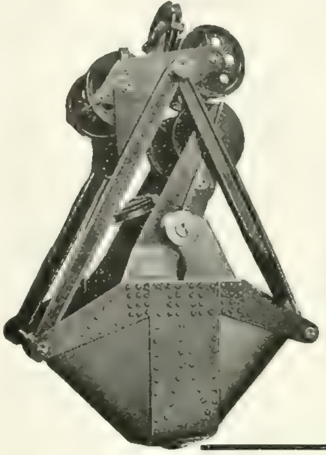
Are successfully used for handling all Materials, Dredging or Excavating.

All excess weight eliminated; therefore, require less power to operate.

Do not have to be dropped from a distance to fill, digging ability due to a distinct and powerful system of leverage.

THE KIESLER COMPANY
68 PRATT STREET :: :: CHICAGO, ILLINOIS

Gumbo



On the Detroit Tunnel Job the contractors, Dunbar & Sullivan, found only one bucket that could dig "gumbo clay" in the river, and that was the "Faivrette" bucket. They are digging under 75 ft. of water.

We make buckets of all kinds for all kinds of digging. Have you seen an illustration of our single rope bucket working in the bight of the line and doubling the power of the engine in digging? If not, send for it.

G. H. Williams Co.
1531 Rockefeller Building
Cleveland, Ohio

$2.12 per lineal foot saved in the cost of one sewer job.

That's what a Milwaukee contractor saved on an 8x14 foot sewer trench by using a

Little Giant Trench Shovel

(See page 129 Feb. 26 issue Engineering-Contracting.)

You can't lose with one of these machines, because they are fully guaranteed and by simply substituting a short dipper handle, you have a steam shovel suitable for all kinds of excavating and which will handle from 500 to 1,500 cubic yards of material per day. Let us tell you all about them.

FULL INFORMATION ON REQUEST.

THE VULCAN STEAM SHOVEL CO.
102 Vulcan Place TOLEDO, OHIO, U. S. A.

Contractors' Buckets

Of Every Description

Send for Catalog 33

The most complete book ever issued covering Contractors' Machinery and Supplies.

H. Channon Company.
Chicago.

STEAM DREDGES

We originated the Power Bank Spuds and are fully protected by U. S. Patent. All infringements will be prosecuted.

Steel Gear, Return Flue Boiler, Plain Belt Frictions, Up-to-Date Practical Money Maker, Built to Run Without Repairs.

Our Dredges are known all over the country, and every owner, operator, runner and cranesman of a Fairbanks Dredge is our friend.

SEND FOR CATALOG No. "D"

The Fairbanks Steam Shovel Company

MARION, OHIO, U. S. A.

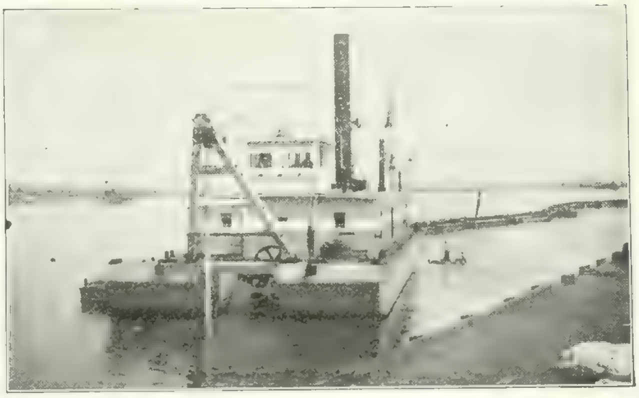
J. E. MARBAUGH, General Agent, Monterey, Ind.
JERRY SHERWOOD, Minnesota Agent, Litchfield, Minn.
J. W. WOODWARD, Southern Representative, 409 Carondelet St., New Orleans.

500 Cubic Yards An Hour

This is what the "San Pedro" dredge has excavated in San Pedro Harbor, Cal. The material is sand, shells and clay, which is conveyed through a 20-in. discharge pipe for 1,600 ft. The present Ellicott Hydraulic Dredge Fleet—as it may be called—has a capacity of 50,000,000 cu. yds. a year.

SEND FOR INFORMATION ABOUT ELLICOTT DREDGES.

ELLICOTT MACHINE COMPANY
Designers and Builders
BUSH STREET BALTIMORE, MD.



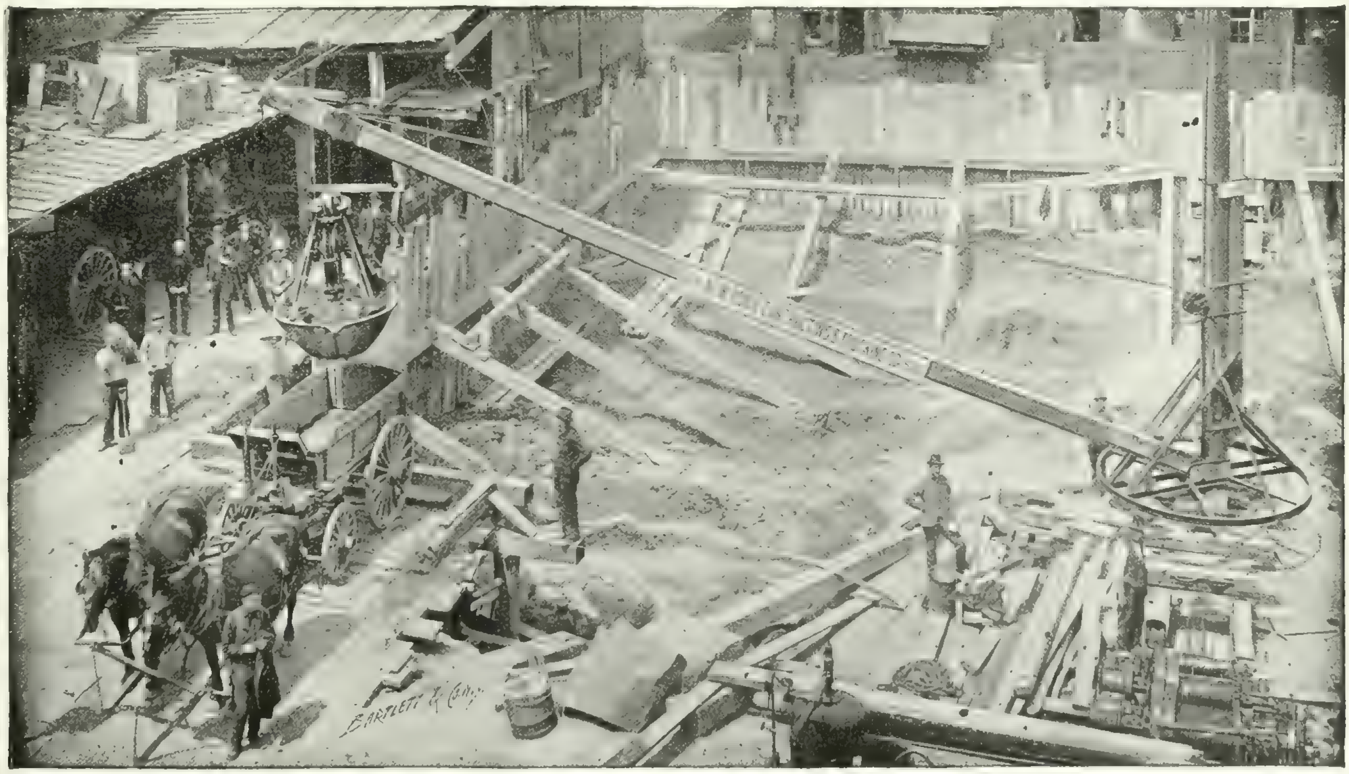
The U. S. Hydraulic Dredge "San Pedro"

For Digging Cellars

Few contractors appreciate the wide range of usefulness and the economy of Hayward orange peel and clam shell buckets. This picture is only one of scores in our catalog, showing the saving of labor effected by using Hayward buckets. They are designed to dig hard earth and they do it

Hayward Buckets

The Hayward Co.
50 Church Street
NEW YORK



FOR HIGHEST
EFFICIENCY and ECONOMY

USE

WOODHOUSE
SPECIAL DREDGE

ON

Steam Shovels, Cranes and Dredges.

Made ONLY by

Woodhouse Chain Works
Trenton, N. J.

COPY OF TESTIMONIALS FURNISHED ON REQUEST.

HIGH GRADE
CHAIN

for use on Dredges, Cranes and Steam Shovels made by hand by skilled workmen from special selected material and tested.

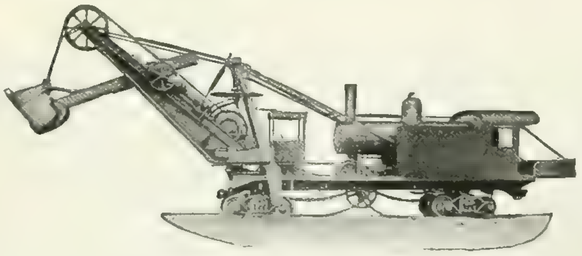
If you will specify our "XX" quality chain all your troubles will cease. You can get what you want when you want it by writing to us and asking for prices and CATALOGUE "EC." Our reputation is both our recommendation and your guarantee as to quality.

Trade "XX" Mark

MADE ONLY BY

The Hayden-Corbett Chain Co.
190 Lorain Ave., Columbus, O.

ATLANTIC STEAM SHOVEL



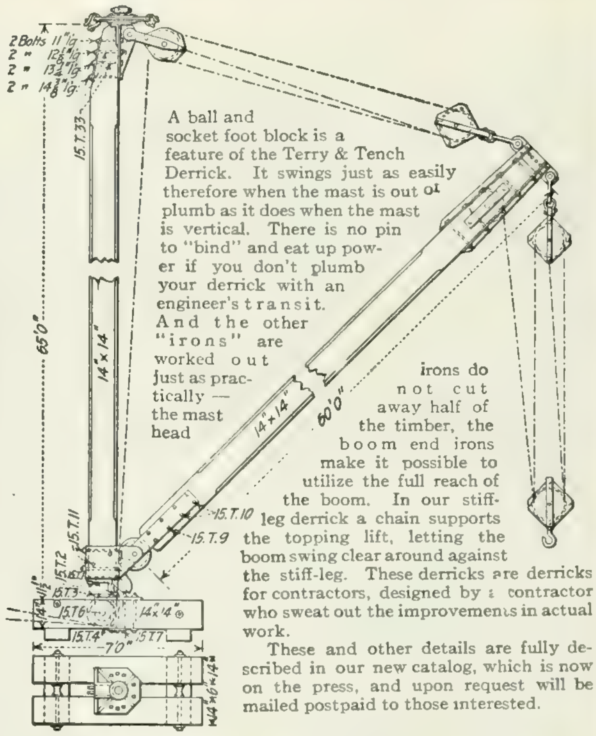
Great weight in a steam shovel makes it cumbersome and difficult to hold up on temporary rails and soft ground. The Atlantic Steam Shovel is of moderate weight, simple in design, and has few and strong parts that will not break or get out of order.

ATLANTIC EQUIPMENT COMPANY

Railway Exchange
Chicago

30 Church Street
New York

A Derrick that Does Not "Bind" when the Mast is Out of Plumb

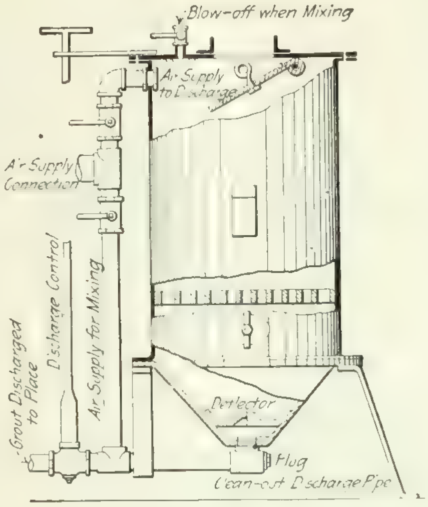


A ball and socket foot block is a feature of the Terry & Tench Derrick. It swings just as easily therefore when the mast is out of plumb as it does when the mast is vertical. There is no pin to "bind" and eat up power if you don't plumb your derrick with an engineer's transit. And the other "irons" are worked out just as practically — the mast head irons do not cut away half of the timber, the boom end irons make it possible to utilize the full reach of the boom. In our stiff-leg derrick a chain supports the topping lift, letting the boom swing clear around against the stiff-leg. These derricks are derricks for contractors, designed by a contractor who sweat out the improvements in actual work.

These and other details are fully described in our new catalog, which is now on the press, and upon request will be mailed postpaid to those interested.

THE TERRY & TENCH CO., Incorporated
2173 Lexington Avenue, New York City

Canniff Pneumatic Grout Mixer and Injector (Patented)



Used on Belmont and Pennsylvania Tunnels.

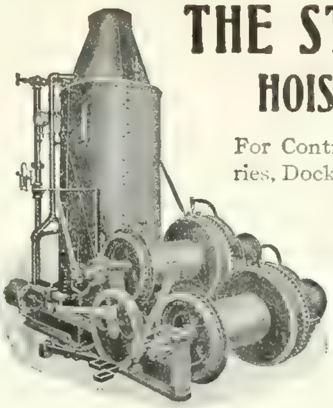
Mixed and placed 410 batches in 10 hour day.

Capacity 2 bags.

Pressure 70 to 150 pounds.

FURTHER PARTICULARS UPON REQUEST.

TIDE WATER IRON WORKS
HOBOKEN, N. J.



THE STROUDSBURG HOISTING ENGINE

For Contractors, Pile Driving, Quarries, Dock and Bridge Building, Sewer and Railroad Construction, Conveying and Operating Trench Machines and for all work where a stiff strong engine is required.

The Stroudsburg Engine Works
STROUDSBURG, PA.

EARTHWORK—And its Cost

By HALBERT P. GILLETTE, M. Am. Soc. C. E.
Editor ENGINEERING-CONTRACTING

A book that should be in the hands of every man who is in charge of "moving dirt," whether with pick and shovel, plow and scraper, steam shovel and dredge, or any other tool for digging and conveying earth. The contents include:—

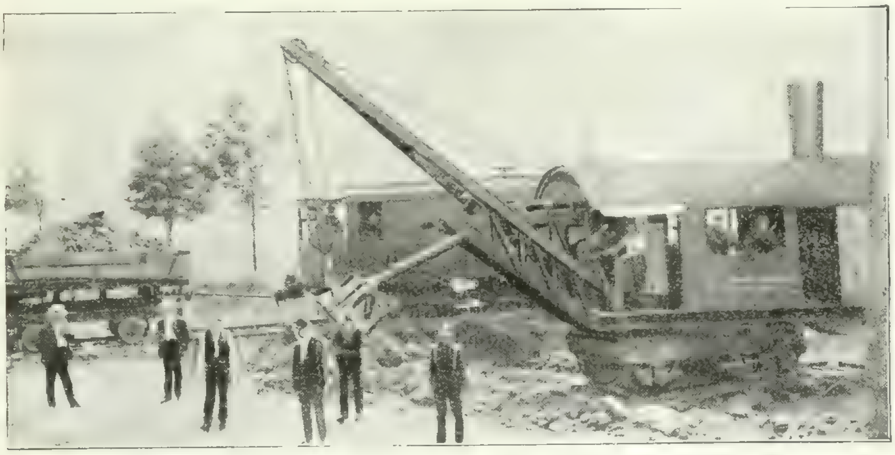
The Art of Cost Estimating—Earth Shrinkage—Earth Classification—Cost of Loosening and Shoveling—Cost of Dumping, Spreading, Rolling, etc.—Cost by Wheelbarrows and Carts—Cost by Wagons—Cost by Buck and Drag Scrapers—Cost by Wheel Scrapers—Cost by the Elevating Grader—Cost by Steam Shovels—Cost by Cars—How to Handle a Steam Shovel Plant—Summary and Table of Costs—Cost of Trenching and Pipe Laying—Cost of Hydraulic Excavation—Cost of Dredging—Miscellaneous Cost Data—Earth and Earth Structures—Rapid Field and Office Survey Work—Overhaul Calculation—A Small "Home-Made" Dipper Dredge or Steam Shovel—Detailed Description and Drawings—Cost of Making the Dredge—Cost of Operating.

Cloth, 5x7½ in., 260 pages, 50 figures and illustrations; $2 net postpaid.

WRITE FOR DESCRIPTIVE CIRCULAR

THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, CHICAGO, ILL.

A Steam Shovel for Shallow Digging



Thew Shovel in Boulevard Construction

A cut as shallow as 18 inches can be readily made with a Thew Shovel. Moreover, this shallow cut can be made without abnormal demand on the shovel and its operator. This is because the Thew Shovel has a **horizontal dipper crowding motion.** No other shovel can have this motion. This feature of the Thew Shovel, coupled with its ability to swing through a complete circle and excavate and load on all four sides, makes it the most perfect machine ever built for grading streets and for shallow stripping operations of all kinds. The fact that one man alone, with occasional help from the teamsters, can operate the shovel, makes it, in addition, the most economical machine.

Send for CATALOG No. 10 giving records of shallow digging with Thew Shovels.

The Thew Automatic Shovel Company, Lorain, Ohio

IN WRITING to our Advertisers for CATALOGS or PRICES please mention ENGINEERING-CONTRACTING.

Three books in one.
The world's authority on this great subject.
The most expensive book ever issued and sold for only $5.00.

Concrete and Reinforced Concrete Construction

By HOMER A. REID, Assoc. M. Am. Soc. C. E.

906 pages; 715 illustrations; 70 tables; $5 net, postpaid

200 working drawings of bridges, bridge piers and culverts; 60 working drawings of sewers, water mains and reservoirs; 30 working drawings each of retaining walls and dams; 200 working drawings of buildings and foundations, including shops, roundhouses, etc. Every structure illustrated is described, the method of construction is explained and where possible the cost is given. There are chapters telling **how to compute girders, arches, columns, tanks, bins, walls, conduits and chapters on proportioning, mixing and laying concrete,** on **doing concrete work in freezing weather,** on **facing and finishing concrete,** on **waterproofing concrete,** on the **physical properties of concrete,** on **cement testing** and on **concrete block manufacture and construction.**

This book contains more text pages, more drawings and **more tables of test data on concrete and reinforced concrete construction than any other book in the world. It has more new matter**—material never previously published. This work is a combination of several books in one; **it is complete, up-to-date and original. No other book on concrete contains one-tenth as much of the very latest data on tests, theory and practice.** The cost to publish this book has been more than double the original estimate, but the price will for the present remain at $5 net postpaid.

EVERY ENGINEER AND CONTRACTOR SHOULD HAVE A COPY

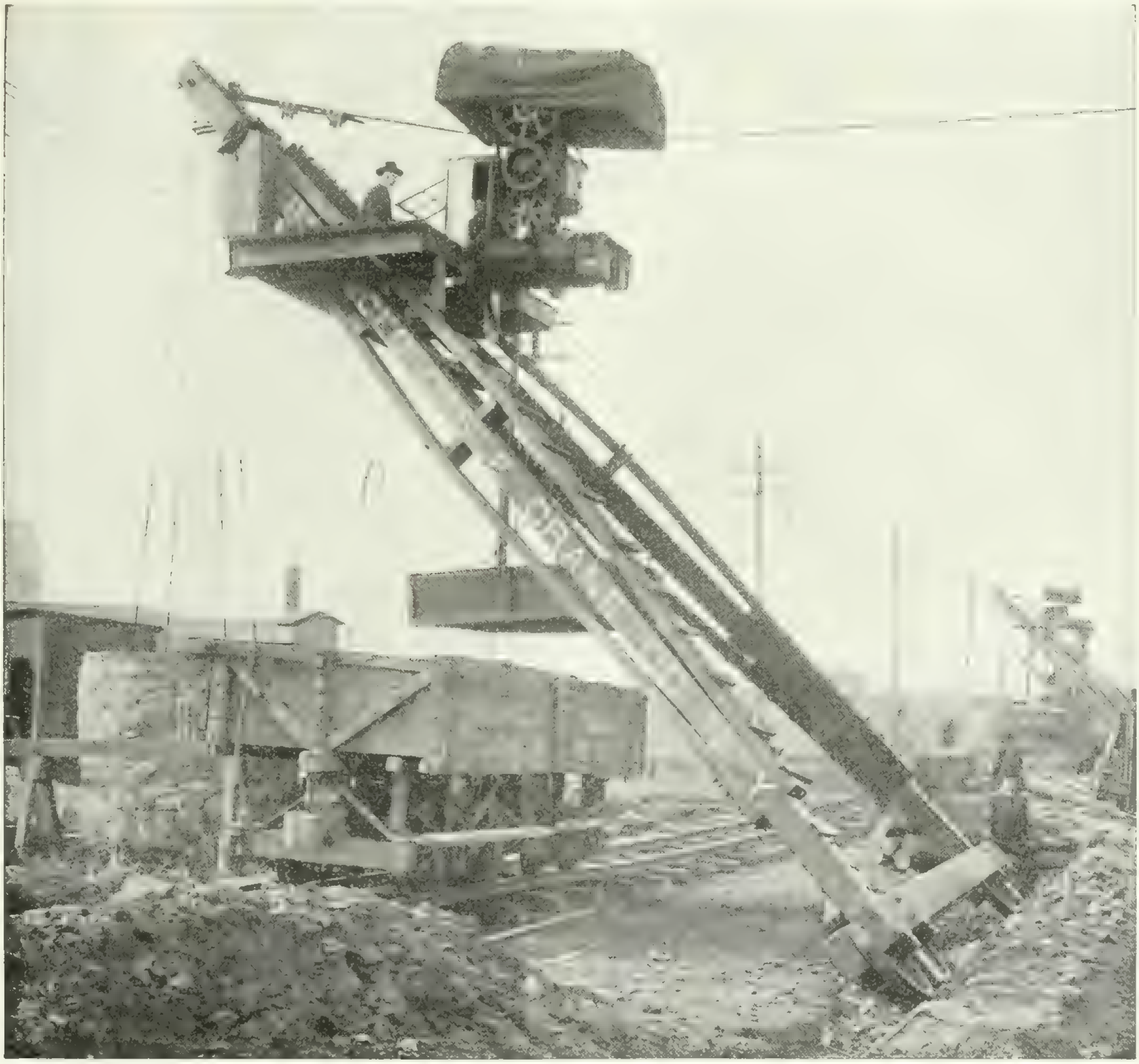
Write for 16-page Table of Contents.

THE MYRON C. CLARK PUBLISHING CO.

355 Dearborn St., CHICAGO

Why The Oscillating Tower Eliminates The Dead Load

BY counterweighting a heavy window a child can raise it, because the child has merely to overcome the comparatively slight resistance of friction of the pulleys. In like manner, by providing an oscillating tower we make a cableway that is counter-balanced; and, as a result, **the electric motor is a child in size** compared with the engines used on any other type of cableway. In brief, our motor does not have to lift the dead load, nor does it have to overcome the grade due to the sag of the cable. Due to the oscillating tower and its counterweight, the sag in the cable becomes less and less as the trolley and its load approaches the tower. The counterweight goes down and the trolley rises, and the result is **precisely the same as if the trolley were running on a level track.**



Showing Battery of Balanced Cable Cranes at work on the Erie R. R. cut, Bergen Hill, Jersey City. Capacity of 5 tons load lift at 80 feet a minute. Traveling speed 1,500 ft. per minute. But one rail under each end of cableway.

Our catalog explains not only the theory which accounts for this remarkable result, but it gives numerous examples of existing plants whose operation proves the result. Send for our Catalog No. 2C.

THE BALANCED CABLE CRANE CO.

133 WILLIAM STREET NEW YORK CITY

JOHN W. ALVORD, C. E.
Consulting Engineer
For Hydraulic and Sanitary Works
Hartford Building,
CHICAGO

THE AMERICAN BUREAU OF INSPECTION AND TESTS
Consulting and Supervising Engineers
Inspection of Railway and Structural Materials
Cement Testing—Chemical Analyses—Physical Tests
Monadnock Block, Chicago
29 Broadway, New York. Wabash Bldg., Pittsburg.

THE ARNOLD COMPANY
ENGINEERS-CONSTRUCTORS
ELECTRICAL — CIVIL — MECHANICAL
181 LA SALLE STREET
CHICAGO

FRANCIS W. COLLINS
Civil and Mining Engineer
Steam and Electric Railroad Valuation
Late Principal Assistant to Halbert P. Gillette on the Appraisal of the Railways of Washington
535 West 142nd Street, NEW YORK

WILLIAM R. CONARD
Assoc. M. Am. Soc. C. E. Assoc. M. Am. Soc. M. E.
3 West Broad St., BURLINGTON, N. J.
Inspection of Rails, Bridge Materials, Building Materials of Iron and Steel, Cars, Locomotives, etc.
SPECIALTY: Inspection of Pipes and Specials, and all Water-Works Materials.

CORNWALL, PLOCK & SALTZMAN,
Civil and Mechanical Engineers.
West Street Building, 140 Cedar Street, New York City.
Designs, Plans, and Specifications for Power, Refrigerating and Industrial Plants.
REINFORCED CONCRETE CONSTRUCTION
Expert Examinations, Reports and Supervision.
GENERAL ENGINEERING FOR CONTRACTORS.

CHARLES COTTINGHAM
Civil and Consulting Engineer
DANVILLE, ILL.
Surveys, Plans, Specifications, Estimates and Superintendence
Water-Works, Water Purification, Sewerage, Sewage Disposal, Street Pavements, Electric Lighting, Topographical Surveys, Grade Systems

C. A. CRANE
Assoc. M. Am. Soc. C. E.
Civil and Consulting Engineer
Supervision of regulating and grading contracts, sewers and paving. Excavations and foundations measured. Estimates of quantities on contract plans. Engineering design and construction.
505 Tremont Avenue, NEW YORK

E. C. CRUM
Civil Engineer and Constructor
Reconnaissance, Surveys, Plans, and Superintendence. Railroads, Sewers, Street Pavements, Topographical Surveys.
32 W. Patrick Street, FREDERICK, MD.

C. S. DAVIS
M. Am. Soc. C. E.
M. Am. Ry. Eng. & M. W. Assn.
Consulting Engineer
Bridges, Buildings, Substructures and Reinforce Concrete Construction
1128 Ohio Building TOLEDO, OHIO

HOWARD EGLESTON
Constructing Engineer
427 James Bldg. CHATTANOOGA, TENN.
I plan and superintend erection of plant for contractors saving large amounts in costs of operation.
Contractors not regularly employing an engineer will profit by writing me

FIELD, FELLOWS & HINDERLIDER
Consulting Engineers
Irrigation
Water Supply
Drainage
Municipal
Hydro-Electric
Power Development
Topographic Surveys
Contractors' Estimates
319 Symes Building DENVER, COLO

Rudolph Hering George W. Fuller
HERING & FULLER
Hydraulic Engineers
and Sanitary Experts
170 Broadway, NEW YORK
Specialties: Water Supply, Water Purification, Sewerage and Sewage Disposal.

J. B. HOGG
Civil and Mining Engineer
UNIONTOWN, PA.
Railroad Construction.
The Development of Coal Properties

J. W. HOWARD, C. E., E. M.
PAVING EXPERT ENGINEER
And Pavement Testing Laboratory
Write for particulars
1 Broadway NEW YORK

RICHARD C. HUSTON
Member W. S. E Civil Engineer
HATTIESBURG, MISS.
Specialties: Water-Works, Sewerage, General Municipal Work and Appraisals

GRANBERY JACKSON, C. E.
Assoc. M. Am. Soc. C. E.
Water Supply, Electrical Plants
Water Power, Municipal Improvement
NASHVILLE, TENN.

W. G. KIRCHOFFER, C. E.
Member Western Society Engineers
Consulting Engineer
Vroman Building MADISON, WIS.

CLARENCE MAYER
Cost Statistician and Facilities Engineer.
Author of
Telephone Construction—Methods and Cost.
Expert Advice on Construction Costs.
Cost Systems Established. Estimates Made.
904 Ellsworth Bldg. CHICAGO

JAMES B. McCORD,
Assoc. M. Am. Soc. C. E.
Civil Engineer
42 Broadway NEW YORK
Water-Works, Filtration, Reports on Properties of Public Service Corporations

THE MEADE TESTING LABORATORIES
Richard K. Meade, Director
Clarence E. Kline, Manager
Experts on the Manufacture, Testing and Analysis of Portland Cement and Its Raw Materials.
Cement Inspection and Tests.
Mill Inspection, Standard Tests, Expert Opinions, Chemical Analysis, Scientific Investigations.
Young Bros. Bldg. NAZARETH, PA.

WM. J. MILLARD
Consulting Engineer and Contractor
911 Hibernia Bank Bldg., NEW ORLEANS, LA.
Reports, plans and estimates. Steam, Electric and Logging Railways, Dams, Docks, Locks, Bridges, Fireproof Buildings, Water Works, Drainage, Sewers, Highways and Swamp Reclamation. Cement Testing Laboratory. Contracts taken and arranged.

E. A. MOLLAN
Formerly with Sanitary District of Chicago
CEMENT TESTING LABORATORY
Established 1898
601 Omaha Bldg., 134 E. Van Buren St.
CHICAGO

HIRAM PHILLIPS,
M. Am. Soc. C. E.
Consulting Engineer
Expert Reports, Plans, Specifications and Superintendence. Hydraulic and Sanitary Engineering.
615 Frisco Bldg. ST. LOUIS, MO.

ALEXANDER POTTER, C. E.
Hydraulic Engineer and Sanitary Expert
143 Liberty Street, NEW YORK
Sewerage and Sewage Disposal
Water Supply and Purification

ISHAM RANDOLPH
M. Am. Soc. C. E.
M. W. Soc. Engrs.
Consulting Engineer
748 First National Bank Building CHICAGO

J. T. RICHARDS
Consulting Engineer
Member Western Society Engineers
716 Chamber of Commerce CHICAGO
Specialty
REINFORCED CONCRETE CONSTRUCTION
GENERAL ENGINEERING AND SUPERVISION FOR ARCHITECTS AND CONTRACTORS

E. L. SHAW
M. Am. Soc. C. E.
Civil and Consulting Engineer
1105 Monadnock Block CHICAGO
Bridges, Buildings, Foundations, Reinforced Concrete Construction, Municipal Public Works.

W. S. SHIELDS
Civil and Sanitary Engineer
Water-Works, Sewerage Systems, Pavements, Railroads
1201 Hartford Building; CHICAGO
Telephone Central 3871

W. L. STEBBINGS
Civil and Consulting Engineer
Monadnock Block
CHICAGO
Specialties: Bridges and Steel Construction of Every Description
Water Supply, Sewers, Factory Buildings, Etc.

WALTER E. TRUESDELL, C. E.
Civil and Mill Engineer
7 West 38th Street NEW YORK CITY
Reinforced Concrete, Industrial Plants, Estimates, Reports, Consultation. Especial attention given to Engineering for Contractors.

J. G. WHITE & COMPANY
Incorporated
Engineers, Contractors
43-49 Exchange Place, 41-43 Wall Street
NEW YORK, N. Y.

London Correspondents:
J. G. WHITE & COMPANY, LIMITED
9 Cloak Lane, Cannon Street

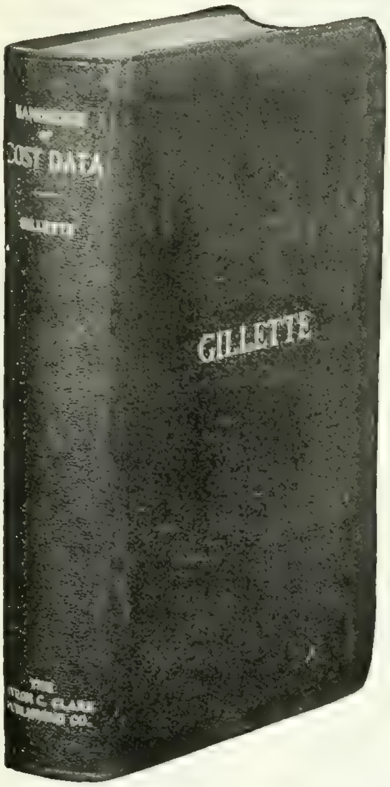
Canadian Correspondents:
CANADIAN WHITE COMPANY, LIMITED
Sovereign Bank Bldg., Montreal

Principal Philippine Office: Manila, P. I.

W. W. YOUNG
Consulting Engineer
St. Paul Building, NEW YORK CITY
Examinations, Estimates and Financial Reports

YOU
are asked to help us to increase our influence among engineers and contractors, not already subscribers to our paper.
Send Us Their Names

SPECIAL OFFER



The author of "Handbook of Cost Data" is also the editor of **Engineering-Contracting** and no person interested in Engineering Construction of any kind can afford not to have both. The demand for "Cost Data" has broken all records for the sale of technical books, over 14,000 copies having been sold during the first 2½ years. The growth of **Engineering-Contracting** is even more wonderful. This is the only periodical in the world devoted to **METHODS and COST** and the only weekly Civil Engineering paper west of New York. We want 15,000 additional subscribers and ask **YOU** to help us secure them. The net price of "Cost Data", flexible leather, gilt edges, 622 pp., is $4; the subscription price of **Engineering-Contracting**, 52 issues, is $2. We will send **both for $5.** If already a subscriber, you may have the paper sent to a friend. We will mail either to whatever address you desire and the price is **only $5** if one cash order covers both. (Canada $6.)

"Cost Data" has over 600 pages of **actual costs** taken from the **private records** of **engineers** and **contractors** and so itemized and analyzed as to be of **inestimable value** to any person who has to do with making **bids** and **estimates** or in checking **estimates.** The book covers the whole field of contract work, giving the cost of labor and materials required for every kind of construction from the laying of sod to the building of reinforced concrete sewers. No detail of contract work has been too small to be described and recorded. Wages and prices of material are given in every case, so that proper substitution can be made where conditions differ. It gives also valuable data on **methods of construction,** thus enabling foreman to handle work in the most economical manner possible.

The general headings are:

Cost-Keeping, Preparing Estimates, Organization of Forces, etc
Cost of Earth Excavation.
Cost of Rock Excavation, Quarrying and Crushing.
Cost of Roads, Pavements and Works
Cost of Stone Masonry.
Cost of Concrete Construction of all Kinds
Cost of Water-Works.
Cost of Sewers, Vitrified Conduits and Tile Drains.
Cost of Piling, Trestling and Timberwork
Cost of Erecting Buildings
Cost of Steam and Electric Railways
Cost of Bridge Erection and Painting
Cost of Railway and Topographic Surveys
Cost of Miscellaneous Structures

Better order this book TODAY

ENGINEERING-CONTRACTING, 355 Dearborn St., CHICAGO

We Are
Manufacturers of
Contractors' and
Railway Supplies.
Write for catalog "A"
Union Elevator &
Machine Co.
144-6 Ontario St.
Chicago

You will be interested in this new book on VAULT and SIDEWALK LIGHTING

It gives interesting details on the subject, explains Berger's Raydiant System of construction, tells how to specify, order and install, shows typical installations, etc.

WRITE TODAY FOR A COPY ASK FOR F-37-V

Berger's Raydiant has advantages you should know about. It combines economy of installation with maximum efficiency. Get posted about it.

Agents Wanted Everywhere.

Contractors, Concrete Workers, or others who are prepared to handle and install this class of work will find the agency for this system a desirable one to have. Write us **right now** for details.

THE BERGER MFG. CO., Canton, Ohio
New York, Philadelphia, Boston, Chicago, St. Louis, Minneapolis, San Francisco, Atlanta

The Controlling Altitude Valve

maintains uniform stage of water in Reservoirs, Stand Pipes and Tanks

"No Overflowing in Case of Fire Pressure from Pumps"

No waste of water. No float fixtures. Every superintendent and engineer should investigate our Steam and Water Valves. WRITE FOR CATALOG "EC."

The heaviest line of
Automatic Valves and Traps
for High and Low Pressure Steam and Water Service ever presented to users.

GOLDEN-ANDERSON VALVE SPECIALTY COMPANY
Offices: Sixth and Duquesne Sts., PITTSBURG, PA.

"AMERICAN"

The Advantages of Rope Transmission

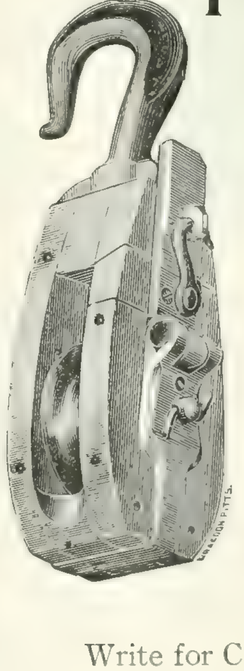
American Manila Transmission Rope demonstrates its notable superiority over all other known means for the distribution of power in the following directions:

1. The distance through which power may be transmitted is practically unlimited.
2. The amount of power which may be transmitted is practically unlimited.
3. Low first cost and economy in maintenance.
4. Small space occupied for horsepower transmitted.
5. Positive, steady operation.
6. Freedom from noise.
7. Absence of static electrical disturbances.
8. No loss of speed by slipping.
9. Precise alignment of shafting not necessary.
10. Enormously high mechanical efficiency.
11. Simplicity of arrangement for all requirements.
12. Simple and inexpensive provision for future additions to power.

Every essential detail in the design, erection and maintenance of Rope Drives is covered in our valuable 64-page "Blue Book of Rope Transmission." Copies free upon request.

The American Manufacturing Co.
65 Wall Street, New York
Makers of American Transmission Rope, Largest Fibre Workers in the World

TRANSMISSION ROPE



PATTERSON BLOCKS

ARE THE BEST

ALL sheaves bushed and hook made from staybolt iron and flattened.

Write for CATALOG No. 2 "EC"

W. W. PATTERSON CO.
54 Water Street, Pittsburg, Pa.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER,
CHAS. S. HILL,
C. T. MURRAY,
F. A. SMITH, . . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . PRESIDENT
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance):—
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.

Copy for regular advertising must be received not later than Friday preceding date of issue in which it is to appear. "Proposals," "Wants" and "For Sale" announcements can be inserted as late as Tuesday morning.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

The Educational Advertisement and Why the Interest in It is Perennial.363
The Limitations of Concrete as a Material for Columns..................364

CONCRETE SECTION:

Some examples of European Use of Concrete Piles in Wharf and Dock Work 364
Some of the Methods of Cuban Block Makers and Cement Workers......365
A High Cost for a Reinforced Concrete Lining of a Canal............366
A Comparison in Economy of Reinforced Concrete, Cast Iron and Steel Column Construction 366
Cost of Rubble Concrete in the Granite Reef Dam of U. S. Reclamation Service 368
A Concrete Bucket Designed for Depositing Concrete in Narrow Forms.368

EARTH AND ROCK SECTION:

An Excess Curve of Quantities of Trapezoidal Canal Sections.........369

GENERAL SECTION:

Proposed New Rooms of Western Society of Engineers.................370
Method of Laying Tar-Rok Sub Floors 373
A Deep Well Water Supply..........373

LETTERS TO THE EDITORS:

The Ethics of the Ashokan Reservoir Controversy 371

METHODS AND COSTS:

Shooting Wells—Stopping Holes in Steel Conduit—Data on Sewage Purification at Providence, R. I.—Checking Earth Slides.............372

The Educational Advertisement and Why the Interest in It Is Perennial.

All advertising is educational in that it supplies information, but we prefer to apply the word educational to that class of advertisements whose object is to educate the public to the use of a particular class of product regardless of the particular firm that makes it. For example, the books issued by the Atlas Portland Cement Co. are educational advertisements, their aim being to disseminate knowledge as to concrete construction. So far as most of the Atlas books are concerned, they are so free of any direct advertisement of Atlas cement that they might well bear the "compliments" of any other cement company.

Does this sort of advertising pay? In our judgment it pays richly, for, while the name of the advertiser is not stamped on every paragraph of the publication, it is stamped upon the memory of the reader by virtue of *the association of ideas.* Give a man a good pocketknife and he is likely to think of the giver very frequently when he uses the knife. Yet your name is not stamped upon the knife to remind him. The association of ideas is sufficient. So, too, when a firm gives a good catalog and when it supplies useful information in an advertisement, the association of ideas serves to impress the name of the firm upon the reader of the catalog or advertisement.

The drumming advertisement becomes wearisome if it is persisted in without variation, hence it is wise to use educational advertisements for variety. A few manufacturers publish "house organs" of the educational sort, and doubtless find it profitable to do so. We believe, however, that they would find it infinitely more profitable if they were to put the same money and brains into a series of educational advertisements in the best periodicals. It is true that they could not furnish the same bulk of reading matter without undue expense, but readers are already burdened with bulk, and what they now seek is *quality.* One column a week of truly valuable data published in the advertising pages of a good journal would be read by more people, several times over, than now read the pages of the best "house organ" in the world.

Why have advertisers been slow to recognize this fact? The answer seems clear. As soon as an advertiser has prepared an article containing valuable data, he is tempted to send it to a number of journals as a contributed article for their reading columns. Now, the best journals do not care for contributed articles that are not their *exclusive* property. Hence the article is likely to be rejected by several of the journals when they learn that it is not to be exclusively theirs. This is discouraging, but what is even more discouraging is the blue-penciling that the article is apt to receive. Even a sugar coated pill of advertising in the article may be rejected by the editor. So, all in all, writing educational advertising articles for the technical press is discouraging, to say the least.

Faced by this trouble, the advertiser turns to the "house organ" or the periodical circular as a solution of the problem. In doing so he overlooks the splendid opportunity that exists in the advertising pages of high class periodicals. There he will find an audience of many thousand men, ready to listen if they but hear a voice other than the voice of the "barker." Most advertisements, as they are now gotten up, are like the cry of the "ballyhoo man," calling attention to the fact that there is a show (a catalog) going on inside. Why not stage the show outside, where all can see? Why not give a performance that all will pause to see? It can be done, and the wonder is that so few advertisers have appreciated the possibilities in this line.

If each advertiser were to print some valuable, original facts, figures or suggestions in his advertisement every week, the readers of a journal would form not only the habit of looking for new information in the advertising columns, but would form the habit also of clipping out advertisements and pasting them into a scrap book.

Along with the educational matter thus published, the advertiser can weave in some direct advertising without making it obnoxiously prominent.

It takes work to produce a series of educational advertisements, but it takes work, anyway, to sell a product, and no work brings richer returns than that devoted to the education of the buying public by means of advertisements. Certain firms could profitably insist upon having their salesmen send in data and practical hints every week, for use in educational advertisements. Salesmen are constantly seeing good "tricks of the trade" in use by contractors and others for economizing labor, and such "tricks" form the best kind of educational advertising.

It would pay many a firm to employ an engineer whose sole duty would be to travel about gathering material for educational advertisements such as we have outlined above.

If these things were done, the advertising pages of a journal might rival the reading pages—and why not? The advertising section would thus become a community "house organ" of the highest value. It is our belief that this is the trend of technical advertising as dimly foreshadowed by the few educational advertisements that are now appearing.

On the merits of any machine there is a limit to the arguments that may be advanced. Hence there is a limit to the "drumming advertisement." But there is no limit to the educational advertisement describing the use of any product. Hence the educational advertisement possesses an interest that is perennial.

The Chinese Government owns a telegraph system covering 22,419 miles of lines.

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

The Limitations of Concrete as a Material for Columns.

Two weeks ago we gave a large amount of space to records of tests of hooped concrete columns, and pointed out some of the practical limitations which these records indicated. On another page we publish a consideration of the concrete column which serves to indicate still further its limitations. The facts brought forward in this last discussion are by no means new but they have seldom been stated so specifically, and for that reason they merit careful reading. It should be observed that the thing proved is not that the concrete column has no place in building construction but that its place has quite definite limits.

The fact of these limits will come as a surprise to some engineers. There will be some also who will vigorously deny their truth. It has been and will again be pointed out that structures of 10 and 15 stories have been built with concrete columns and are in every respect durable and sturdy structures. No one can dispute this claim, but it does not meet the criticism presented. The facts are that under the same conditions a concrete column while costing only half as much as a steel column takes up from two to three times the room that a steel column will. This comparison, moreover, is made with a steel column filled and covered with concrete so that the matter of fire resistance is evened up.

In buildings where the space occupied is of small consequence and where great durability is sought the concrete column has an important place. Elsewhere some other type of column construction is likely to be superior. It may be the type in which the steel is sufficient to carry the load and the concrete envelope serves merely to add stiffness and fire protection and a factor of safety. It is more likely to be the type in which the steel forms a column large enough to carry the dead loads and construction loads and the encasing concrete adds enough strength to care for the live loads. The last type is substantially the type used in the McGraw building mentioned in the article in another page to which we have referred.

There is no good reason why columns of either of these two types should not be used in connection with reinforced concrete floors and, if wished, with reinforced concrete walls, roof and other building parts of concrete. Other reasons than true engineering reasons have fostered the idea that the all concrete construction possessed superiority over the combination construction. The facts are that the all-concrete type is cheaper and best under certain conditions while the combination construction is under different conditions the cheaper and better. This is the point clearly indicated in the article referred to and it is the point which makes that article of direct value.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Some Examples of European Use of Concrete Piles in Wharf and Dock Work.

The following is abstracted from a paper by Luther Wagoner entitled "Notes Upon Docks and Harbors," appearing in the Proceedings American Society Civil Engineers, Vol. XXXIV, page 446. The paper is to be presented before the society on Sept. 2, 1908:

Concrete piling has been used in Ravenna, Venice, Boulogne, Rotterdam, Hamburg, Southampton, and a number of places. Speaking generally, the experience has been satisfactory, although in some cases serious difficulty has been encountered in driving such piling. Some trouble was observed in Hamburg, where concrete piles, from 30 to 36 ft. long, were being driven for the launching ways of a shipyard, many of the piles being badly broomed and broken. In this case, they were driven in a sand fill, without the use of a water-jet.

Southampton is the best place at which to observe such work as experience there covers a longer time, and the piles are of greater dimensions than elsewhere. At the time of the writer's visit, 15 by 18-in. piles, 60 ft. long, were being driven as sheet-piling at the front of a quay wall which had failed by sliding outward. These piles were driven about 30 in. in front of the wall by using a jet and a steel bonnet lined with a cushion of sawdust. The penetration was 28 ft., a heavy steam hammer being used for driving. Embedded in each pile near its center there was a ¾-in. iron jet pipe with an elbow about 2 ft. from the top. At the bottom this pipe was screwed into a cast-iron point; the nozzle opening was ⅜ in. The pressure was 200 lbs. and the quantity of water used was from 5.5 to 6 cu. ft. per minute. At least 60 days was allowed for seasoning. No trouble was experienced in driving, and no brooming or breakage was noticed.

At this place there is a coal wharf on reinforced concrete piles which also has diagonal braces of concrete and a concrete deck. This wharf has been subjected to an unusual amount of buffeting and hard service, and is quite elastic. Two piles which were broken off under water by a collision were repaired by divers. The broken parts were removed, then an iron tube was inserted and caulked in place, after which the tube was pumped out and filled with concrete.

Extensive improvements being under way for the London & South Western Railway (the owner of the docks), their engineer, Mr. Shields, had just completed a careful inspection of all concrete work. He reported that all work below water was in sound condition, but that a few remarkable cases of rusting and exfoliation had occurred above the water, for which no satisfactory explanation could be found. In this the writer saw a very strong resemblance to the failure of expanded metal in concrete floors, reported to the Structural Association of San Francisco in 1906. As a final result, it was decided that for any new work at Southampton, there should never be less than 2 ins. of concrete covering the reinforcement, both above and below water.

At Paris the writer was informed by E. T. Quinnette de Rochemont,* M. Am. Soc. C. E., that although the length of experience with reinforced concrete piles was not greater than from 5 to 7 years, he was favorably impressed, and that the Corps of the *Ponts et Chaussées* would use them freely if the conditions required it.

Young's million-dollar pier at Atlantic City is an example, on a large scale, of the use of concrete piles. These piles have a riveted case of 3/16-in. steel to which is secured a concrete point. They were hoisted into position and filled with concrete to a depth about equal to the water; they were then lowered and put down by jetting about 15 ft. into the sand, care being taken to have the concrete filling at all times above the surface of the water. There are no reinforcing rods, and, when the outer galvanized cylinder fails, the structure must depend upon the tensile strength of the concrete to resist the lifting action of the waves, which, owing to the exposed position of the pier, may be quite severe during a storm.

In Paris the writer witnessed a demonstration of the †Compressol method of preparing foundations. By a sort of pile driver, a heavy conical weight is dropped repeatedly upon the soil, and when the desired depth is obtained, small stones are dropped into the hole, and, by special forms of conical weights, are forced down and out into the soil, after which concrete is rammed into place by the same means. A completed pile will generally be 40 ins. in diameter and have a bulb at the base.

---

*Inspecteur Général des Ponts et Chaussées.

†See Engineering-Contracting, Oct. 16, 1907, page 220.

One contractor in Belgium has eighteen of these machines at work. There are many places where such a system might be used; its special value would appear to be in a firm soil of loam requiring piling, and where the pile tread would be above the permanent water plane. Whether, in point of economy, it presents any advantages over some of the patented American systems is not known by the writer. It is asserted, by those advocating the compressol system, that owing to the thorough compression given to the ground, both laterally and vertically, combined with the mushroom shaped base of the pile, it is capable of sustaining two or three times as much load as piles used in American systems. Certainly there must be considerable merit in it, otherwise it would not be used so extensively.

The Wear of Concrete.—Most of the quay walls observed in Europe are faced with rubble or ashlar. In Belgium, Holland and Germany they have a rubble facing of hexagonal basalt blocks about 2 ft. deep, to prevent wear. In the Albert Dock, London, a concrete non-faced quay wall has been in use about 30 years, and, having been subjected to much buffeting from lighters as well as ships, it has worn away about 2 ins.

Careful inspection was made as to a possible action at or near the water line due to freezing, or wave action, or both, but nothing noteworthy was seen. However, at Baltimore there is a noticeable exception, for, on certain bridge piers, and for a vertical range of 18 in., the concrete has disintegrated to a depth of several inches about at the ordinary water line. Aside from the affected part of the concrete, which was covered with a vegetable growth more dense than in the lower unaltered part, nothing unusual was observed. The concrete above and below the affected zone is good.

Various theories have been advanced to account for the decomposition. The most plausible one is that with a small tidal range there is a destructive action by the waves lapping the affected zone, and this, perhaps, is assisted by ice action. None of the theories suggested, when weighed and considered in reference to similar structures elsewhere, appears to the writer as tenable. Believing it worthy of investigation, the matter has been reported to the United States Geological Survey, with a request for an investigation and report.

As a means of checking tuberculosis in the principal cities of Brazil, the sanitary authorities of that country have instituted a campaign involving the expenditure of $1,250,000.

The two headings of the Loetschberg Tunnel, Switzerland, have penetrated the mountain 12,644 ft.

Some of the Methods of Cuban Block Makers and Cement Workers.

BY GEORGE RICE.*

In Cuba they make concrete blocks on somewhat different plans from those employed in the United States. The Cuban concrete block maker uses wood molds to a considerable extent, one of which is shown by Fig. 1. Recently the manufacturers of concrete block making machinery of other countries have been shipping modern forms of machines for this work into the country, with the result that there are certain block makers in possession of these machines. But the greater proportion of concrete block making is done with the cruder types of devices. The business is a good and profitable one in Cuba, for the reason that at the present time there are many new structures in process of erection, and the tendency towards concrete blocks is very pronounced. Cuban architects utilize considerable stone and cement work in all of their buildings. There are but very few fires in the country. Floors, walls and ceilings are all of the stony or cement material. Much of the surfacing is polished and looks well.

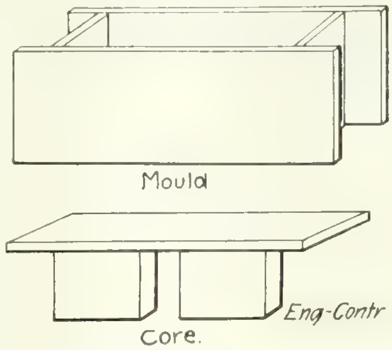


Fig. 1.

In the manufacture of concrete blocks, the native workman measures off the sand in the usual way and adds to it the cement. Ordinarily the proportion is four parts of sand to one of cement. Then the water is run in to the extent of making the stuff pliable without causing it to stick to the molds. A great trouble has been this matter of the stuff adhering to the molds, because of excessive wetness. Too much water likewise makes the work flabby. It is liable to settle and become soggy when removed from the molds. It may warp and turn. On the other hand, if too dry, the stuff cannot adhere well and may harden prematurely and crack. In fact, the manufacture of blocks with the somewhat defective apparatus used in the average Cuban plant is somewhat difficult.

The wooden mold is set up in the fashion exhibited by Fig. 1. A bottom is placed in and then the affair is filled by shovelling the mixture of cement and sand into it. Next comes the tamping. The tamping in this country is done with a device constructed of hardwood, shaped as shown in Fig. 4. Sometimes one native does the tamping and sometimes two. Lads are employed for this work. The tamping should by rights be done by skilled men. All the particles should be tamped until the block is compact from bottom to top. The smallest voids should not exist. Air spaces will ruin the block as all know. Blocks are also made under heavy pressure by mechanical apparatus, but most of the blocks are tamped by hand.

Some of the mechanical tamping devices I saw in use were constructed to compress the blocks from all sides at one time, resulting in the development of thin layers, preventing the air from escaping from the interior. The air is simply compressed inside and air holes result. After the mold is tamped good and full, the process of floating off is performed, by using a device to scrape off the surplus material which may have piled up beyond the edges of the mold. A pallett is pushed along on the exposed side and this side is properly smoothed.

The mold is now ready to turn so as to get the core out. Fig. 1 shows one of the plain patterns of cores. The core is quite easily loosened by pounding on the wood with a hammer. The core is then lifted directly upwards without marring the edges of the form. Fig. 2 shows the form of the mold when locked up and a finished block is shown by Fig. 3. Fig. 4 shows some of the devices employed in the shaping of blocks to some special design. A gutter tool is exhibited and a combination mallet and one of the trowel devices shaped for doing cornering work. An edger of the Cuban pattern is also shown and a jointer.

Curing is by no means a simple operation. I have seen good blocks ruined at the curing. On the other hand, defectively molded blocks are often improved in the curing operation. One should pile the blocks as closely as possible together and keep them under cover, free from the effects of high winds and storms. The Cuban does not always realize this. He takes chances on the weather and places the blocks outside where they are oftentimes rained upon before they are cured. After the material in the blocks is set, a spray can be discharged upon them with good effect, and this is done in some of the works. More often, water is deluged over the blocks at intervals and chances upon regularity of curing are taken. After

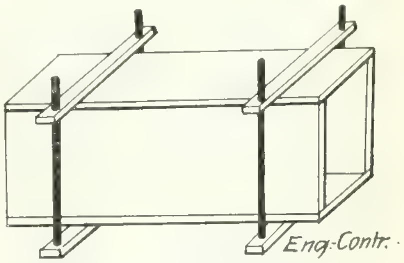


Fig. 2.

---

*Melrose Highlands, Mass.

several days, the blocks will absorb no more moisture, as a rule, and then the middle curing of two weeks' duration occurs. Of course, rush orders come along, and rather than lose the opportunity for business, the manufacturer of blocks in this country, like the manufacturer of blocks in the United States, takes the chances on letting the goods go before the blocks are completely cured. He makes a mistake by doing this. Sometimes the error is a serious one and his business is handicapped for a long time afterwards. It is best to get a good stock ahead and draw upon the thoroughly cured stock only, no matter how great the inducements may be to sell ahead of time.

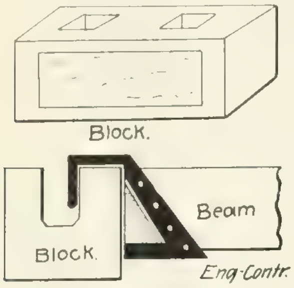


Fig. 3.

Figure 3 is a drawing of one of the styles of block mostly used in Cuba. It also gives a sketch of the system usually employed here for supporting the end of a beam on a block wall. The blackened portion represents the gripping device in iron. These grips are molded in wrought iron and are very strong. They are bolted to the ends of the beams.

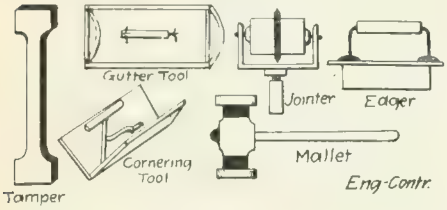


Fig. 4.

The water filtration works of Pittsburg, Pa., are to be extended and bids are now being asked until June 29 for the excavation, grading, concrete work, track system and main pipe systems in connection with the ten additional filters. The auxiliary filter equipment will be advertised subsequently, and it is hoped by July 1. Additional work to provide filtered water to the city of Allegheny, recently annexed to Pittsburg, will probably be advertised by fall. This work will include additional machinery at the low level pumping stations and an entire new pumping station to take water from the new filtered water reservoir and deliver into the Allegheny main, which passes through the filtration works. Morris Knowles is chief engineer, Bureau of Filtration.

A High Cost for a Reinforced Concrete Lining of a Canal.

We have been furnished with the following figures by Mr. A. P. Davis, chief engineer of the U. S. Reclamation Service, on the cost of some reinforced concrete work being done by a contractor for the U. S. Reclamation Service.

The concrete is being cast in the shape of a half cylinder 8 ft. in diameter and 2 ft. high, and is designed for the lining of a canal on the side of a canyon, which is very difficult of access. The shapes for this lining are being manufactured on a wagon road in the bottom of the canyon, where water and other materials are available, and are hoisted by a cableway and placed in the canal, the successive shapes being cemented together to form the lining of the canal. The figures given include only the manufacture of the shapes and do not include the placing.

The following wages were paid for an 8-hour day:

Foreman	$3.00
Power house supt	4.16
Mechanic and electrician	3.00
Timekeeper	2.67
Concrete mixers	$2.50 to 3.00
Common laborers	2.50
4-horse team and driver	7.00
2-horse team and driver	$4.50 to 5.00

The plant used on the work was, two No. 2 Aurora rock crushers, two half yard size Chicago concrete mixers, and Studebaker one yard dump wagons for hauling sand, gravel and cement. Collapsible steel forms for molding concrete shapes were used, centrifugal pumps and modern pipe for wetting concrete, a cableway and a power plant consisting of a Morgan Smith turbine, a Walker generator, transmission line, electric motors, etc.

The costs given are for work done from Aug. 3 to Nov. 9, 1907, in which time 3,216 shapes were cast, amounting to 1,468 cu. yds., there being in a single shape about 0.45 cu. yds.

The cement and steel were furnished by the government to the contractor at the nearest railroad station, and it cost the contractor $4.50 per ton for delivering. The cement cost the government delivered at the nearest railroad point $2.68 per barrel. An average of 1.22 bbls. per cu. yd. of concrete was used last season. The reinforcing steel cost, at the nearest railroad point $0.0278 per lb. Placing the steel cost the government 1½ cts. per lb.

Sand and gravel cost, delivered at the crusher, $1.23 per cu. yd. of concrete, 98 cts. of it being for the hauling. The sand used was such as would pass through a screen, four meshes to the inch. The gravel passed through a 1 in. screen.

The mixtures used were 1-3-4, and 1-2¾-4¼. The cost per cubic yard was:

Plant and fixed charge	$ 5.25
General expense	1.77
Grading and leveling	0.17
Excavating and hauling sand and gravel	1.23
Screening sand and gravel and mixing concrete	0.55
Cement	3.27
Hauling and placing concrete	1.90
Placing reinforced metal	0.28
Setting up and taking down forms	2.67
Cleaning and oiling forms	0.33
Laying bases	0.71
Wetting concrete	0.38
Total per cubic yard	$18.51

This includes the cost of all materials and labor, except the cost of the reinforcing steel. The large item of "fixed charges" is due mainly to the cost of forms, which are made of steel and a large number of which are used. Thus nearly $5 per cubic yard is the cost of the material in forms, making the entire cost about $8 per cu. yd. for material and labor in forms.

This cost for concrete is extremely high, even considering the wages paid, and likewise the cost of materials. It would seem that some error in judgment was made as to the methods selected in doing the work, or that the laborers were not well managed.

A Comparison in Economy of Reinforced Concrete, Cast Iron and Steel Column Construction.*

There are many considerations involved in the proper design of columns for buildings. The questions include not only the cost of the column, but also the space taken up and the value of that space for other purposes. Reinforced concrete columns, while cheaper in first cost, are larger in diameter than steel or cast iron columns, because of the larger unit stresses used in the latter. It is the purpose of this article to compare the different types of columns to find out under which conditions the greatest economy is secured.

Concrete columns are made in a number of ways, having the concrete held in place by vertical rods hooped together with wire wound either horizontally or in a spiral around the vertical rods. The stresses allowed per sq. in. vary from 350 lbs. to 1,000 lbs.

Cast iron and steel columns are used largely in building construction. The cast iron columns are made hollow with either a round or square section and the steel columns are built up by the use of plates, angles, channels, I-beams or other structural shapes riveted together. The columns should be fireproof with tile or concrete at least 2 ins. thick so as to resist the action of fire.

Taking the case of a ten-story building with floor loads of 200 lbs. per sq. ft. and a roof load of 120 lbs. per sq. ft., we will compare the cost of construction of concrete columns with steel and cast iron columns. We will assume the floor panels as 16 ft. × 20 ft. equals 320 sq. ft. The load for ten floors and the roof will be 678,400 lbs. We will take the horizontally hooped concrete stress at 750 lbs. per sq. in. Making no allowance for the vertical rods, and the spirally hooped column at 1,000 lbs. per sq. in. for the concrete and 8,000 lbs. per sq. in. for the vertical rods, as allowed by the code of the Borough of Brooklyn. The cast iron and steel columns are figured from the Cambria handbook. The results of these stresses give the following sizes for the different columns.

---

* Reprinted from an article in "Cement Age," May, 1908, by H. C. Hutchins.

Horizontally hooped concrete column, 34 x34 ins. square.

Spirally hooped concrete column, 30 ins. round.

Cast iron column, 20 ins. round, 1⅝ ins. metal.

Steel column composed of two channels 15ins.x45 lbs. and two plates 20x¾ ins.

The cast iron column is the smallest in size of all the above kinds. The space required will be according to the following table:

Kind of Column.	Area in sq. ft. column section.	Percentage of panel taken up by the column. Per cent.
Horizontally hooped concrete	8.03 sq. ft.	2½
Spirally hooped concrete	4.9 sq. ft.	1.53
Cast iron column	2.18 sq. ft.	0.68
Steel column	3.41 sq. ft.	1.07

The cast iron and the steel column were figured with 2 ins. of concrete around them for fireproofing, making the C. I. column 20 ins. diameter and the steel column 20x16½ ins.

The cast iron column is the most economical of floor space, and the concrete columns require much more. We will take the case of a downtown office building where the floor space rents for $3.00 per sq. ft. a year. It would be worth more to the person renting the floor space to have the smallest size of column. If we take the case of a 20-story building, the figures above would represent an average of all the floors as they are the figures at the tenth floor. The value of the floor space taken up by the columns per year will be as follows:

Kind of columns	Area covered.	Value at $3.00 per year.
Horizontally hooped concrete	8.03 sq. ft.	$24.09
Spirally hooped concrete	4.9 sq. ft.	14.70
Cast iron column	2.18 sq. ft.	6.54
Steel column	3.41 sq. ft.	10.23

The cost of construction of these columns will be figured on the following basis:

Rock concrete in place	$7.00 per cu. yd.
Cinder concrete for fireproofing columns	4.50 per cu. yd.
Forms for square concrete column	0.80 per lin. ft.
Forms for square concrete column	1.00 per lin. ft.
Cast iron columns in place	0.03 per lb.
Steel columns in place	0.04 per lb.
Reinforcing steel for concrete column in place	0.03½ per lb.
Spiral bands for hooping	0.05 per lb.

The form of column requiring the greatest floor space is the horizontally hooped concrete column, which at the same time costs the least to build. Now the question arises whether the reduction in cost compensates for the extra floor space taken up. Taking a comparison between the horizontally hooped concrete column and the cast iron column we find a difference in cost of $8.03—$3.27, or $4.31 per foot. For an average height of floor of 11 ft. the difference in cost per floor for each column would be $4.31×11, or $47.41.

TABLE OF COST OF CONSTRUCTION—PER LINEAL FOOT.

Kind of Column.	Concrete.	Metal.	Centering.	Total.
Horizontally hooped concrete	$2.07	$0.85	$0.80	$3.72
Spirally hooped concrete	1.27	1.68	1.00	3.95
Cast iron column	0.13	6.90	1.00	8.03
Steel column	0.18	7.68	0.60	8.46

The difference in the value of the floor space per year would be $24.09—$6.54, or $17.55. From these figures it can be seen that the cast iron column while costing 2.16 times as much would save its cost in economy of floor space in less than three years.

In a factory where the floor space is renting from 25 cents a square foot it would take the cast iron column twelve times as long to save its extra cost of construction, or about 35 years, which is longer than the average factory building stays unchanged.

In a factory building three stories high we would have the following sizes of columns for purposes of comparison:

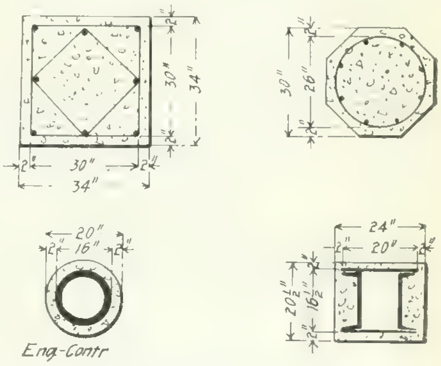
TABLE OF COSTS FOR A THREE-STORY FACTORY.

Kind of Column.	Size, Ins.	Area of Section, Sq. Ft.	Value of Space, Per Year.	Column Cost, Per Ft.
Horizontally hooped column	20 x20	2.78	$0.70	$1.58
Spirally hooped column	18 round	1.77	0.44	1.83
Cast iron column	13 round	0.92	0.23	2.68
Steel column	12½x16	1.39	0.35	2.69

In this case the concrete columns are decidedly cheaper in every way than the steel or the cast iron. The difference in the value of the space between the horizontally hooped concrete column and the cast iron is $0.70—$0.23, or $0.47, saved in the space per year, while the difference in cost of construction for a single column 11 feet long would be $2.68—$1.58×11, or $12.10. It would therefore take the cast iron column 26 years to save its extra cost by economy of floor space.

It will be seen by this method of analysis that the more expensive forms of column construction are cheaper in the end for high buildings where the floor space is valuable, while for factories and warehouses that are not too high greater economy results in the use of concrete columns.

The designs of the columns for buildings should take this feature into account, and each should be figured to see which form of column will give the greatest economy. Where property values are high, as in the business districts of the large cities, high buildings are built to obtain the greatest income possible from rents and leases. Every square foot of space becomes valuable and the columns and walls should be designed to take up the least area of renting space available. Where this is the case the economies in space resulting from the use of cast iron and steel columns are great enough to warrant their use.



Comparative Dimensions of Reinforced Concrete Cast Iron and Steel Columns for the Same Loading.

When the land is not so valuable and lower buildings are built, then the concrete column is the best in every way. In factories built where land is cheap the superiority of the concrete column is demonstrated, not only because of its lower first cost, but also on account of its adaptability to any class of factory design.

Comparing the use of concrete or brick

for wall piers, let us take up the question of size and cost. For wall piers built of concrete in the form of concrete columns a lower stress than 750 lbs. per sq. in. should be used, as the loading is eccentric. While the exact effect of this is difficult to determine because of the monolithic nature of the structure, lower unit stresses should be used, and so we will use 500 lbs. per sq. in. inside the hooping instead of 750 lbs.

For brick piers when laid in Portland cement mortar 1 to 3 an allowable stress of 250 lbs. per sq. in. may be used according to the New York building code. This stress is one-half that assumed for the concrete, so the size of the piers would be reduced. The following table will show the difference in size and in cost:

	Concrete Construction.		Brick Construction.	
Load on Pier.	Size.	Cost.	Size.	Cost.
100,000 lbs.	12x17	$1.19	17x24	$1.25
150,000 lbs.	15x20	1.57	25x24	1.84
200,000 lbs.	20x20	1.97	24x33	2.42
250,000 lbs.	20x25	2.35	24x42	3.08
300,000 lbs.	20x30	2.76	24x50	3.67
400,000 lbs.	20x40	3.55	24x67	4.78
500,000 lbs.	20x50	4.35	24x84	6.15

The concrete column stress is taken inside the hooping and 2 ins. is added to this for fire proofing.

The costs for the table are as follows: Reinforcing steel in place at 4 cts. per lb. Concrete in place at $7 a cubic yard. Brick laid in Portland cement mortar at $20 per thousand. Forms at $28 per M ft. in place.

Concrete construction for columns is cheaper than cast iron or steel and can be used to advantage for buildings such as factories, cold storage warehouses, and business blocks, where the height is not excessive. When the building is higher than ten stories the space taken up by the columns in the lower floors becomes excessive and must be considered in design. While the concrete columns for a high building are cheaper than cast iron or steel columns, the value of the space used must not be overlooked.

A design combining a steel column with a concrete filling may be used to advantage, giving as a result a column of smaller size and reduced cost. Many designs of this kind have been used. The main point in designing these columns is to arrange the steel so that it forms a column and at the same time acts as a hoop to confine the concrete. The columns used in the McGraw building in New York city fulfill this requirement admirably. (Engr.-Contr., Dec. 19, 1906.) The column consists of four angles placed in the corners of the column and latticed together, all points being spliced, and angle seats for all concrete beams being provided. In these columns the steel acts in an excellent manner with the concrete. The stresses approved by the New York building department for these columns were as follows: Concrete inside the hooping, 750 lbs. per sq. in.; steel (modulus of elasticity 12) 9,000 per sq. in. The cross section of steel must be sufficient to carry the entire dead load above it without stressing the steel above 16,000 lbs. per sq. in.

This design for a concrete-steel column solves the problem of sizes and permits the use of concrete and steel to replace steel or cast iron sections for high buildings.

Cost of Rubble Concrete in Granite Reef Dam U. S. Reclamation Service.

The following costs of placing 1,977 cu. yds. of rubble concrete in the Granite Reef Dam, Salt River Project, U. S. Reclamation Service during arch, 1908, are rearranged from the June "Reclamation Record." There were 437 cu. yds. of rock imbedded in the concrete, making therefore approximately 22 per cent of the total quantity of concrete. The total expense connected with the quarrying, hauling and placing of the rock was $2.70 per cu. yd. The cost of the concrete work for the month was distributed among the following items: Building forms, hauling gravel, hauling cement, concreting, maintenance and operation of track and chute, power, cable expense, imbedded stone and general expense.

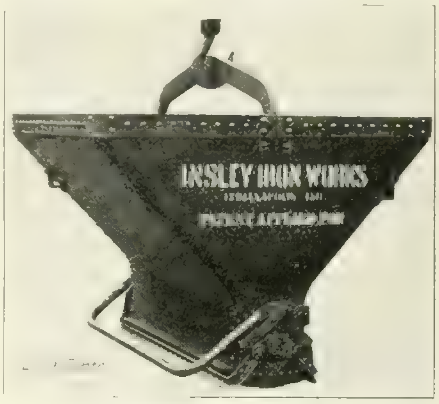
The item of general expense includes a relative portion of the general office expense, and the salaries of the constructing engineer, the assistant engineer and his party, the general foreman and the timekeepers. Laborers were paid at the rate of $2.00 to $2.25 per eight-hour day, carpenters at the rate of $3.00 to $4.00 per day, and teamsters at the rate of $2.25 per day. The cement used in the concrete cost $1.85 per barrel at the mill. All of the work was conducted in the river but above the foundation walls. The cost of forms was considerable on account of the curved down stream face of the dam.

The unit cost per cubic yard of the concrete in place, exclusive of the cement, was as follows:

Item.	Per Cu. Yd
Building forms	$0.30
Hauling gravel	0.67
Hauling cement	0.12
Concreting	0.61
Maint. of track and chute	0.05
Power	0.04
Cable expense	0.17
Imbedded stone	0.16
General expenses	0.35
Total cost exclusive of cement	$2.47

A Concrete Bucket Designed for Depositing Concrete in Narrow Forms.

In many kinds of concrete work it is required to place the material in narrow forms or in comparatively thin sheets. To do this successfully, when the placing is done directly from buckets, requires a bucket of special construction differing distinctly from the construction of buckets for mass concrete work. The bucket shown by the accompanying cut has been designed to embody these distinctive features. It is, as will be observed, a bottom dump bucket, the two doors of which open right and left from a center joint by means of a positive gate action. This gate action permits positive control of the opening; it can be made of any width up to the full swing of the gates. By this means the concrete can be discharged without spilling directly into narrow girder or wall forms, or, by swinging the bucket, in a thin sheet to form a floor or roof slab. Another point to be observed is that the discharge always being directly downward and more to one side, there is no "side kick" or recoil of the bucket in discharging to knock and displace the forms. The positive control of the gates makes it possible to empty any part or all of the contents at will, as well as to control the speed of the discharge. The arrangement of the gate operating lever and toggles is plain from the illustration. All parts of the bucket are of steel and all pin bearings are bronze bushed.



Concrete Bucket for Narrow Forms.

The bucket illustrated is known as the Form Bucket. Another style of bucket is made in which the sides are more nearly vertical and the discharge opening, therefore, greater. This is known as the Pier Bucket from the use to which it is usually put. These buckets are made by the Insley Iron Works, Indianapolis, Ind., and are handled by Mr. Geo. M. Chandler, general sales agent, Indianapolis, Ind.

The survey of the Chining-Changchun line, in China, which is to be built jointly by Chinese and Japanese, has been completed. The cost of the line is estimated at $6,300,000.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

An Excess Curve of Quantities for Trapezoidal Canal Sections.*

BY HARRY F. SOVEREIGN.

To assist in the paper location of canals, the following curve was designed in a field office of the United States Reclamation Service. It was found to be so useful that a short description of it will not be amiss. The curve will find its greatest use in the location of canals in a country which has a fairly uniform slope, although it also proves to be of great assistance in very rough ground.

Canal location presents one point which differs from the location of railway lines: the fact that the excavation must be of a depth to furnish a sufficient quantity of material to build both side embankments and no more. This depth of center cut is called the economic cutting and varies for different transverse slopes of the ground; that is, in a country which has a general slope of 20 per cent, the center cut must be much greater than the proper center cut for level sections, even though the upper bank is dispensed with.

In some sections of the country it is thought to be good practice not to build any upper bank where the ditch crosses a gully or runs transversely along ground which has a slope of 10 per cent or over, thus allowing the water to back up in the gullies and form ponds which receive the run-off and save the canal bank from being topped in many instances. The curves illustrated in Fig. 2 were plotted on this basis.

The economic cut may be determined by calculating the quantities of excavation and embankment in the usual way, and finding the excess of one over the other. At the theoretical economic cut the excess will change from embankment to excavation. The accompanying table shows the excavation and embankment quantities for level sections and differences of center cut of every two-tenths, for a section similar to that illustrated in Fig. 2 and of the following dimensions: Bottom width, 5.0 feet; depth, 3.5 feet; top width, 4.0 feet; side slopes, 1½ to 1. It will be seen that the excess changes from embankment to excavation at a center cut of 2.1 feet.

Base 5.0, Depth 3′ 5, Top Width 4′.0.

Cut.	Exca.	Emb.	Ex. Exca.	Ex. Emb.	Fill
0.0	0	240	...	240	3.5
0.2	4	218	...	214	3.3
0.4	8	198	...	190	3.1
0.6	13	180	..	167	2.9
0.8	19	160	...	141	2.7
1.0	25	142	...	117	2.5
1.2	31	126	...	95	2.3
1.4	37	110	...	73	2.1
1.6	44	96	...	52	1.9
1.8	52	82	...	30	1.7
2.0	60	70	...	10	1.5
2.2	68	58	10	...	1.3
2.4	77	46	31	..	1.1
2.6	86	36	50	..	0.9
2.8	96	26	70	..	0.7
3.0	106	15	88	..	0.5
3.2	116	10	106	...	0.3
3.4	127	4	123	...	0.1
3.5	133	0	132	...	0.0

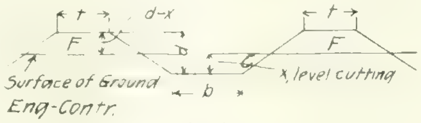


Fig. 1.

This value may be determined algebraically as follows: Referring to Fig. 1, x is the center cut, b is the bottom width or base of the section, t the top width of the embankment, d the depth; side slopes 1½ to 1. The areas of the sections of the excavation and each embankment will be called C and F respectively and will be used instead of volumes to which they are directly proportional:

$$C = bx + \frac{3x^2}{2}$$

$$F = t(d-x) + \frac{3(d-x)^2}{2}$$

The condition for economic cutting is that the cut shall provide material enough to make both fills,

or $C = 2F$.

Substituting,

$$bx + \frac{3x^2}{2} = 2\left[t(d-x) + \frac{3(d-x)^2}{2}\right]$$

Reducing,

$$3x^2 - (2b + 4t + 12d)x + (4td + 6d^2) = 0$$

Solving,

$$x = \frac{(b + 2t + 6d) + \sqrt{(b + 2t + 6d)^2 - 3(4td + 6d^2)}}{3}$$

This is the general equation for any trapezoidal section with side slopes of 1½ to 1, and the numerical value of the economic cut may be found by substituting in the formula the proper values of b, d, and t.

For the section before mentioned,

$$x = \frac{(5 + 2 \times 4 + 6 \times 3.5) + \sqrt{(5 + 2 \times 4 + 6 \times 3.5)^2 - 3(4 \times 4 \times 3.5 + 6 \times 3.5^2)}}{3}$$

$x = 2.09$ ft.

This is the theoretical value of the economic cut since it takes into account neither shrinkage nor wastage. These losses should always be considered, as they may amount to as much as 15 per cent in light soils, in which event the proper condition would be

$C = 2.3F$

For the sake of clearness, and as Fig. 2 is more of a diagram than a set of actual working curves, the shrinkage of the material has not been considered.

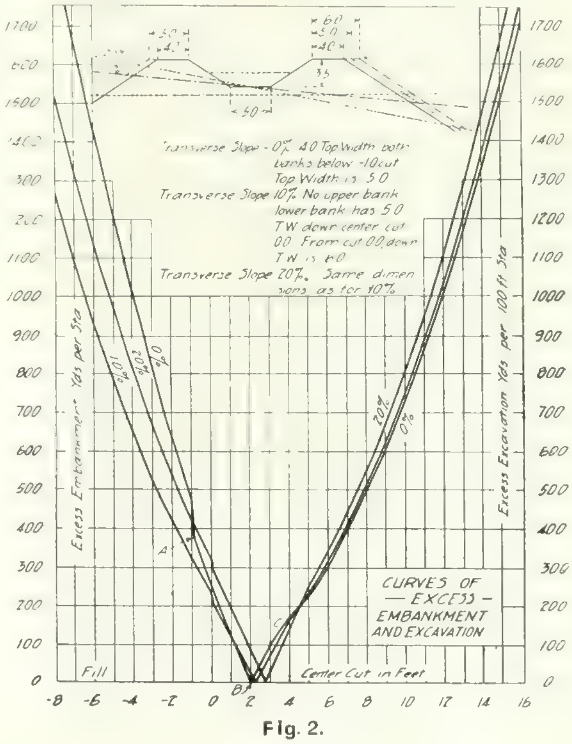


Fig. 2.

It will also be noticed that

$e = C - 2F$

e being the excess area of excavation over embankment. Substituting in the values of the section previously mentioned and introducing the proper factor to give cubic yards per station we have

$$e = \frac{100}{27}\left(\frac{3x^2 - 68x + 129.5}{2}\right)$$

This equation applies to that portion of the curve having 0 per cent transverse slope, marked *A B C*.

---

*Reprinted from the University of Colorado Journal of Engineering, No. 4, 1907-8.

The co-ordinates for the rest of the curves were found by the computation of quantities in the usual manner, no general algebraic method being available on account of the greatly varying conditions for which curves of this kind are prepared.

The use to which the curves may be put is obvious. When a line has been laid out on paper, a profile may be taken from the topography which has been ploted from the preliminary line as a base, as is usually done in railroad work. Average cuts or fills may then be determined from the profile, and the excess yardages found by entering the diagram at the bottom with these values.

If the cutting is too light to provide sufficient material for the embankment, the line may be shifted up the hill and thrown deeper into cut, after which the readjusted line may be re-examined.

From the curve it is seen that the economic cutting for the canal in ground having a transverse slope of 10 per cent is 2.3 ft., for ground having a transverse slope of 20 per cent it is 2.75 ft., and that a center fill of 5 ft. in ground having a 20 per cent slope requires a center cut of 11.2 ft. to provide sufficient material.

The next convention of the American Society of Municipal Improvements will be held at Atlantic City, N. J., on October 20 to 23, and not October 13 to 16 as was stated in the proceedings of the society published a few months ago. This change of date was made necessary by the fact that the one first published—which is the regular time for the convention of this society—had been previously selected by another large society as the time for holding its convention at Atlantic City, and arrangements already made by it with the hotels, etc., would have interfered with the success of the A. S. M. I. convention. The headquarters will be the Hotel Dennis, where will be held the meetings and an exhibition of municipal appliances.

A final inspection of the intake tunnel of the Lawrence Ave. conduit of the intercepting sewer system of Chicago, Ill., was made on June 14. Construction work on the tunnel was started in the summer of 1905 by Mr. J. P. Agnew, who failed after finishing the shaft and about 30 ft. of the tunnel. The work was relet in August, 1907, the contract being awarded to Mr. M. H. McGovern. Further delay was caused by an injunction, and actual construction was not resumed by Mr. McGovern until December, 1907. The 1,500 ft. of tunnel was completed in a little more than six months, the progress of the work being marked by an almost entire absence of accidents of any kind. The tunnel was designed by Mr. Wm. S. MacHaag, Consulting Engineer, Department of Public Works, assisted by Mr. F. A. Smith, Assistant Engineer.

Unclassified and General Articles

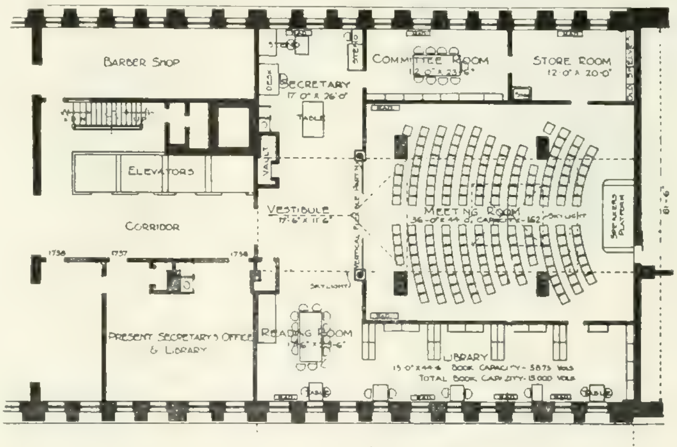
Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

The Proposed New Rooms of the Western Society of Engineers.

With its membership increased to over 1,000, the Western Society of Engineers has completed plans for moving into new and enlarged quarters on the first of September of this year. The work of reconstruction has already been begun and will be continued throughout the summer vacation. While the change will be material in the nature of added space and facilities it will be but slight in location, the new rooms being, like the ones occupied for the last dozen years, on the 17th floor of the Monadnock Block, Chicago. The old home, and the only home which a majority perhaps of the present members recall, will be altered and improved, but it will not be broken up.

With the notice of this change and as a preface to the more detailed explanation of its character which follows, a brief account of the growth of the society will be of interest. The Western Society of Engineers is 39 years old, having been organized with twelve members on May 25, 1869, but for the first twelve years of its life it was known as the Civil Engineers' Club of the Northwest. The change to the present name was made in June, 1880. During its existence as a club the society increased to a membership of 130, and it had had as presidents among others two Mayors of Chicago, Col. R. B. Mason and DeWitt C. Creiger, the noted railway engineer, Charles Paine, and the equally famous hydraulic engineer, E. S. Chesbrough. Indeed the organization has all through its life been noteworthy for the names of the men who have occupied the president's chair, such men as John F. Wallace, Isham Randolph, Octave Chanute, Bion J. Arnold, Alfred Nobel, E. L. Corthell, L. E. Cooley and Geo. S. Morison. Following its change of name the society in 1881 took a distinct forward step by joining with three other engineering societies to organize the now familiar "Journal of the Association of Engineering Societies," as a common vehicle for the publication of the papers and proceedings of these societies. The first issue of the "Journal" was published in November, 1881. The society remained a member of the association until Sept. 24, 1895, when it decided to withdraw and to publish its own journal, and the first issue of the present "Journal of the Western Society of Engineers" appeared in January, 1896.

The growth of the society in membership and financial strength cannot be given here in detail. Briefly, the growth in membership has been about 8 per cent per year from the beginning. In the matter of finances the society has a comfortable surplus over expenditures each year and had accumulated an interest bearing surplus of $12,000 on Jan. 1, 1908. It is with this satisfactory outlook in membership and financial standing that the society will occupy its new home.



Plan Showing Arrangement of New Rooms of Western Society of Engineering.

The new rooms are shown in plans by the accompanying cut. As will be seen, the rooms will occupy the full width of the 17th floor of the Monadnock Block, from the fire-wall separating the old and the new parts of the building south for a length of 62 ft., making a clear space of 62 x 61½ ft. In the interior of this area a space 36 x 44 ft. will be partitioned off to form a meeting room. The U-shaped area outside of the meeting room will be divided into a library and reading room, a vestibule, secretary's office, committee room and storage room as shown. Roughly the new rooms' area will be about double that of the rooms now occupied and in arrangement there will be marked improvement.

The Ethics of the Ashokan Reservoir Controversy.

Sirs—As an interested and humble reader of both sides of the Ashokan Reservoir and Dam Controversy, and as an earnest seeker for more light, the undersigned begs to occupy your space and asks for your interpretation of the general ethics of the recent controversy.

Is it your opinion that the several boards of engineers, with their various consulting engineers, engaged in the matter of the Ashokan Controversy have been reporting upon this matter in an entire spirit of judicious fairness, say in the spirit of fairness that the younger men of the profession rather look for in those higher up, or has one board of partisan engineers stoutly defended an intrenched position against the undermining arguments of an attacking party selected for its presumed ability to tunnel under, blow up and storm simultaneously the intrenched position of the gentlemen opposing?

In view of the fact that the issues seem to have been sharply drawn, is there not some slight probability that both sides to this dam controversy may have been as the knights of old in the fable who fought over the color of the statue, one seeing gold, the other seeing silver, neither party willing to look from the view point of the other, neither party willing to adjust differences with instruments more delicate than tabular sling shots and wordy meat axes in the form of carefully arranged but not absolutely complete and flawless facts, considering that in this vale of tears we are all human and prone to err?

The woods will probably be always full of ambitious contractors, willing to plunge at a venture big or little to the preliminary delight of public and corporate works and to the sorrow of the experienced contractors who are naturally after as handsome profits as they can make and who by virtue of having undergone previous losses feel justified in so bidding as to assure themselves against what they believe to be losses due to entirely reasonable risks. Also we well know that the public shies at large sums of idle capital, reserved to cover contingency risks.

Recent examples might be considered, such as the failures of the contractors to complete their works on the Laguna dam, the Gunnison Tunnel, the Corbett Tunnel, the Bellfourche project in South Dakota, various wind-ups of sub-contracts during the construction of the subway, such as the Onderdunk contract on the East River tunnels, Shaler's contract on the subway, etc., etc., as to warrant many experienced contractors to bid high enough in big works to insure themselves against risks that some other contractors might be willing to overlook on a gamble. There must have been reasons for the numerous failures of original contractors to finish work they began, and we can only judge the future by the past.

At the same time examples might be shown ad libitum where contracts seem to have been let recklessly at random, as, for instance, the Pennsylvania State House work, the proposed contract, which was fortunately abrogated before being put into effect, to feed the men at Panama and permit a contractor to make a profit on what they ate in spite of the fact that our army and navy commissary departments are models of economy and efficiency in times of peace.

The undersigned would not make insinuations of any kind, as he frankly acknowledges that in such matters it is very easy to see through a glass darkly, but it strikes him that it is a great pity that the Ashokan dam *controversy* seems to be monumentally the greatest part of the work done to date, if one may judge from what one reads in the engineering magazines and in the daily press.

The manner of advertising by the method of controversy seems to be an unfortunate scheme for announcing the initiation of such a great structure as the Ashokan Dam and possibly to one engaged in the fight as ENGINEERING-CONTRACTING has been, the spirit of tolerance and fair play which the writer would like to see permeate root and branch through all the problems involving great construction works such as the Ashokan dam and Reservoir, possibly I say the spirit of tolerance of the opposition's ideas is to be deplored as too much of a mollycoddle ideal for these strenuous times, but with all due humility the writer states his belief that just such controversies as this of the Ashokan dam affair do much to undermine the confidence of the public in the engineering and contracting professions. If we are to be torn asunder at frequent intervals with such controversies, then whatever confidence is retained in our profession of the wondering foot will exist due to the popular belief that we are pretty good fellows in spite of the Donneybrook Fairs in which we enjoy ourselves. It is certain that by such controversies as this we are not building up great reputations for ability to make sound judgements and careful adjustments of differences between engineers. And it is this kind of a thing that makes the public look upon engineers as an expensive luxury; everything going out and nothing coming in. Moral: Whenever hard times come, fire the engineers and cut all contracts.

Of course, we all know that men are but boys grown tall, and as long as human nature lasts and as long as there are opposite sides to solid bodies there will be controversies, but is there not some way in this advanced civilization to get at the truth concerning a big work without a fight and a scandal?

The pity of it is that the Deans of the great profession that teaches its tender shoots to make adjustments by the method of splitting differences seem to be able and always ready to forsake least squares, ready at the starters' pistol shot to forget their own teachings of the theory of adjustments, ready and always open for and seeking contracts to furnish fuel and power to maintain meat ax controversies. In the heat of the fray each gladiator dips his ready pen in gore, appealing from the bloody arena to the popular reading galleries, asking the galleries to damn the other fellow at a venture, pleading with the galleries to give the sign "thumbs down."

Where are we at and what is the use?

James Concrete Steele.

The contract for the construction of a new bridge to cross the Nile River at Cairo, Egypt, which will cost more than $1,500,000, has been let by the Ministry of Public Works of the Egyptian government to the Compagnie de Fives-Lilla, of France, after an international competition in bidding for its construction. The new bridge, which will be located at the deepest part of the Nile River and will lead direct to the site where the Boulac Museum stood, is to be built in accordance with plans prepared by the late Sir Benjamin Baker, of London, and The Scherzer Rolling Lift Bridge Co., of Chicago, the latter company also furnishing consulting engineering services during erection. The entire work is to be executed under the charge of the Ministry of Public Works of the Egyptian government, and it is expected that the new bridge will be completed and in service before the end of the year 1910. It has a total length between abutments of 274.5 meters. The total width of the bridge will be 18 meters, divided into two foot-paths of 3 meters each, a tramway track of 5 meters to carry double lines of electric tramway of 1 meter gage, and 7 meters of road clearance. The structure will consist of a Scherzer Rolling Lift Bridge with four fixed approach spans. On the Boulac side of the Nile quay walls will be constructed on masonry wells. The south end of the abutment on this side of the river will join the existing quay wall and the north end will ultimately be joined to the quays under construction. The piers and abutments, which will be of Assouan granite, are to be built on foundations to be sunk by compressed air. The Scherzer Rolling Lift Bridge will have a movable span of 30 meters to allow the passage of boats. In order to facilitate the heavy water and land traffic at this site, which is in the most prominent part of the Egyptian metropolis, the Scherzer Rolling Lift Bridge is designed to operate very rapidly, the time required to open or close the bridge being less than 30 seconds. This result is accomplished by the use of the most modern electric equipment.

The Boston Elevated Railroad is considering installing automatic block signals.

Methods and Costs; Some Old, Some New.

Shooting Wells.—Blasting wells is difficult work, but is easily accomplished by the use of an electrical fuse, which will fire a charge of dynamite at the bottom of a well several hundred feet under water. The charge should be carefully prepared, and it is necessary that the wire and cap connections be well protected with insulating tape. The charge of dynamite is placed in a tin tube provided with a tight fitting cap. A tube 1 in. long is built into the cap, through which the wires are passed; the tube is then filled with beeswax to keep out the water. The dynamite is closely packed in the tube, either by splitting open the cartridges or entirely removing dynamite from the paper wrapper. The joints of the cap are covered with rubber insulating tubes. Under no circumstances should the cover be soldered after the tube is charged. Rubber tape is used to cover the fuse wires up to and beyond their connection with the leading wire. Some well blasters simply tie the cartridges to a stick of wood or an iron rod and lower the charge to the desired position. A charge so prepared, of course, must be fired without unnecessary delay.

Stopping Holes in Steel Conduit.—There are two separate conduits leading from Hemlock Lake to Rochester, N. Y. One of these is a 38-in. steel pipe about 26 miles long, constructed in 1893 and 1894. The pipe is made of steel plates from ¼ in. to ⅜ in. in thickness. The method employed in stopping leaks through pit holes in this pipe has been as follows: The flow of water through the leak is first stopped temporarily by means of a dry pine plug driven into the hole and cut off flush with the outside of the pipe. The coating is then scraped off clean and the metal dried, after which a coat of mineral rubber is applied. A sheet-lead gasket is then beaten down into contact with the concave side of a steel patch curved to fit the pipe, and the patch and gasket applied to the pipe and tightly drawn up by means of a two-part band of ½ x 2 in. iron, bolted together. The edges of the lead are then calked and the whole given another coat of mineral rubber. In some cases where rivet heads hinder the ordinary procedure or where the leak is near the lip of longitudinal and round seams, the steel patch is applied first, spaced a short distance from the pipe, and the intervening space filled with melted lead, after which the edges are calked as before. In cases where the pipe is so weakened as to need a continuous cover plate of considerable size, or where the patch has to cover a series of holes so numerous as to preclude the use of individual small patches, an elastic cement has been used, it being impossible to pour hot lead into the broad thin space under the plate, as it is rapidly chilled by the water in the pipe.

Data on Sewage Purification at Providence, R. I.—The cost of treatment per million gallons of sewage during 1906 at Providence, R. I., was as follows: Chemical precipitation, $3.50; sludge disposal, $3.10. The population served by sewers in 1906 was about 182,000, according to the annual report of Otis F. Clapp, City Engineer. The sewerage system included 205.89 miles of combined sewers and 9.94 miles of storm sewers. The sewage was composed of manufacturing, wool washings, jewelers' dyeing and bleaching wastes, with domestic sewage, and the strength of average sewage (parts per 100,000) was: Albuminoid ammonia, total 0.729; soluble, 0.370; suspended, 0.359; chlorine, 45.58. Other data from Mr. Clapp's report were as follows: Daily flow of sewage in million gallons: Maximum, Dec. 31, 43.5; minimum, Aug. 19, 10.3; average for the year, 20.36. Average daily flow of sewage treated: 19,550,000 gallons. Pounds of lime used per million gallons of sewage (treated): 637.75. Other chemicals used: Copperas, 72.1 lbs. per million gallons. Cubic contents of settling basin up to water surface, when in use, in million gallons: 11.13. Per cent organic matter removed from sewage in terms of albuminoid ammonia: Total, 43.35; suspended, 85.07. Disposition of effluent: Discharged into Providence River off the end of Field's Point under 36 ft. of water. Volume of sludge produced in gallons per million gallons of sewage treated: 4,444.4. Per cent of solids in wet sludge: 7.43. Method of sludge disposal: Pressed and cake hauled by steam train to dump. Sludge pressing: Average number of gallons pumped per day, 86,893. Per cent of solids in wet sludge: 7.43. Pounds of lime added per thousand gallons of sludge: 23.07.

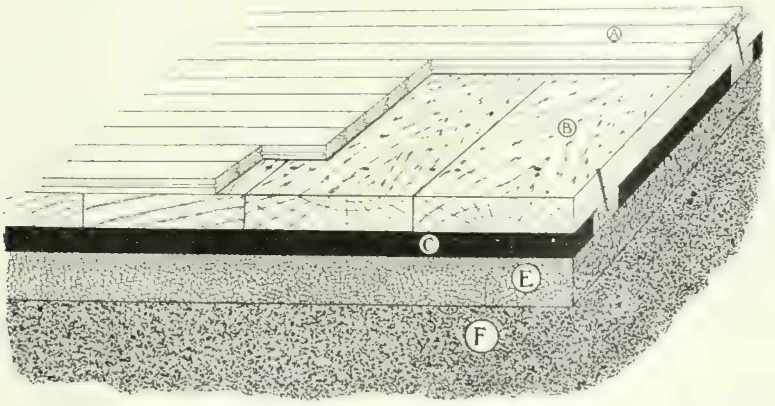
Sludge Disposal.—Description of machinery used: Sludge pumped by Shone ejectors (two, 500 gal.) to storage reservoirs; thence by gravity to forcing receivers (four, 8 ft. dia. x 12 ft. long); thence forced under 60 to 80 lbs. pressure per square inch up into the presses. The ejectors and forcing receivers are run by air pressure generated by one 150 and one 50 h. p. air compressors actuated by electric motors; 18 filter presses are used, each with from 43 to 54 plates, with 6-in. center holes, forming cakes 36 ins. square and from 1¼ in. to ¾ in. thick, between filter cloths which surround the plates. Hours of operation of presses daily: 6.83. For light, heat and power, $7.69 per day. Tons of sludge cake produced daily: 97.16. Per cent of solids in pressed cake: 27.7. Tons of solids in sludge cake produced daily: 26.97. Cost of operation per ton of solids: $2.24. The quantities per day in above table are calculated on basis of 365 days' work.

Checking Earth Slides.—Earth slides formed by masses moving along a rock surface have, in several cases, been checked by boring holes down to rock, lowering dynamite and breaking the surface by means of blasts. In a bulletin of the American Railway Engineering and Maintenance of Way Association, Mr. H. Rohwer, describes a case of this kind. The slide occurred at a railroad tunnel 2,650 ft. long penetrating a sag in the Ozark Mountains, consisting of a so-called boulder formation, lime and rock being found intermixed with clay, a hydrated silica of alumina of brownish color, due to the presence of iron oxide. This clay is very plastic, especially so in the approaches to the tunnel. The clay layer was 5 ft. to 100 ft. thick, underlaid with strata of solid rock of smooth surface and slanting at an angle of from 5 to 10 degrees toward the creek along which the line had been located. The approach to the tunnel had a 20-ft. rock cut with clay in the slope overlying the same. As soon as cracks appeared on the surface extra precautions were taken against surface water. In spite of this the ground continued to break and started to move toward the open cut, until after a heavy rain the entire cut filled up. Though the moving masses had adopted a slope of nearly two horizontal to one vertical, the breaks continued, stretching for more than 150 ft. into the hill above the roadbed, and over 500 ft. distant from the same. To prevent similar occurrences the rock cut was arched over with timber for a distance of 600 ft. from the portal of the tunnel. The clay bank was then removed for a distance of 12 ft. from the edge of the rock cut and holes were drilled into the rock 8 to 10 ft. in depth, and from 10 to 15 ft. apart in a row along the foot of the new bank, shots being placed therein and fired simultaneously by means of an electric battery. The rock was broken but not scattered, a trench-like crack appearing at the surface. Logs were then placed alongside each other with the butt end in the rock crevices, the other end overhanging the timber arch and resting upon its top. The material under the logs and between the logs and the arch was tamped, thus forming a solid flooring over which the material could slide, distributing it over the entire arch and serving as a weight instead of a thrust. The further object of cracking the rock was to permit the water coming through the clay to escape. The plan worked very satisfactorily.

Excavation of submerged reefs at Hell Gate, East River, New York, will be begun this month.

Method of Laying "Tar-Rok" Sub Floors.

In building floors in factories, warehouses and shops, various materials have been used and tried, and all have proven more or less unsatisfactory. Cement floors are cold and damp, and wooden floors rot quickly even with an air space under them or when laid upon concrete. Dirt and cinder floors are dirty and unsanitary, and so objections have been found to each kind of floor. Wooden floors would have been given the preference, except for rapid decay, unless an air space exists under them. To obtain this air space means either a cellar, which is expensive and to a great extent useless (as a cellar frequently becomes damp, it aids in the decay of the floor above it), or an unused air space that means increased height of foundations, piers and walls. In overcoming these various objectionable features of wooden floors the "Tar-rok" sub floors have been successfuly used for many years. This consists of a foundation of whatever local conditions show to be the cheapest, laid on the ground, on which is placed a top coat described below. The planks are laid directly on this top coat without the use of sleepers. A hardwood floor covers the whole surface.



Sketch Showing Section of Tar-Rok Sub Floor.

(A) 1-in. maple, (B) 3-in. hemlock, (C) 2-in. tarred sand, (D) 2x3 nailing strips, (E) 4-in tarred screened gravel, (F) earth.

The tar concrete foundation is laid on the ground, which is leveled to the proper grade to receive it. This foundation consists of 4 ins. of screened gravel or crushed stone, not any of which exceeds 2½ in. in longest dimension, or is less than ¼ in. in size, mixed with sub floor tar No. 3 prepared for this purpose.

If the mixing is done with a machine 25 per cent less of tar can be used. There must be sufficient tar to allow the mixture to compact under a roller after being spread evenly in place. Rolling should continue until the stones do not creep under the roller, which should not weigh less than 300 lbs. to each foot of length. The tar will stand a heat of 200 degrees. In cold weather the stones should be slightly heated.

The tar-concrete foundation is preferable, but in many cases the cost may be prohibitive, consequently a cheap cement concrete can be used, and should be used when the ground is soft and more bridging strength is required than plank will afford.

On this the top coat is put. This coat consists of fine sand mixed with 50 to 60 galls. of No. 5 tar to the cubic yard. The sand has to be perfectly dry for this mixing, but neither the tar nor sand should be at a greater temperature than 225° F. This mixture is spread in a layer 1¼ to 1½ ins. thick. The heavy 3-in. flooring should be laid on this material while it is still soft, thus compacting the top coat. When the planks are properly leveled they are toe-nailed together. The hardwood flooring can then be laid.

The pores of the sand are filled with the tar, and this makes a compact solid floor, as the tar preparation contains creosote it helps to preserve the timber. Wooden floors that usually last from eight to ten years have been found in good condition when laid on a Tar-rok sub-floor after 15 to 20 years of use.

These floors have been used for 20 years, but engineers and architects have not been familiar with the facts regarding them. During the past few years, however, the merit of these floors has been exploited and they are coming into more common use. The sub-floor tars Nos. 3 and 5 are manufactured by the Barrett Manufacturing Co., of New York.

A new law recently in effect in Great Britain provides that foreign patentees must manufacture their inventions in Great Britain within three years after the date of the patent.

The number of vessels built in Germany in 1906 was 760, of 398,151 registered tons, against 646 of 310,771 registered tons in 1905. Among the vessels built in 1906 were eleven men-of-war of 30,831 registered tons.

A Deep Well Water Supply.

The water supply of Copenhagen, Denmark, is entirely from deep sources, reached by 5-in. wells bored through the glacial deposits overlying the stratum of chalk to which, or into which the boring extends. Upon reaching the chalk layer if it is found covered with coarse material the well is not sunk to a greater depth; but if the covering layer is of fine grain, the boring is extended into the body of the chalk itself.

The wells are from 150 to 200 ft. deep and are sunk at a cost of about $1 per foot, according to a paper by Prof. Wm. P. Mason read before the American Water Works Association.

The water is very hard and is ill suited to industrial uses until softened. The city undertakes to remove no mineral ingredients beyond iron carbonate, which latter amounts in the ratio to 4.1 parts per million. The wells are tapped off into a common suction main, whence the water is raised some 60 ft. by triple expansion pumping engines, to the aerating house, where the soluble iron is oxidized to the insoluble form. This aeration and oxidation is accomplished by causing the pumps to deliver the water to a series of open troughs, 28 in number, each one being 12 ft. long, 8 ins. deep and 8 ins. broad. These troughs are movable at either end so that their level may be adjusted. The water overflows their sides and fall in thin sheets into the collection well, 8 ft. below, whence it flows by gravity through a conduit of some 14 miles length to a filter plant within the city limits. The old filters are nine in number, each measuring 75 x 150 ft. The rate of filtration is 8 vertical inches per hour and the depth of the sand bed is about 4 ft. The sand used is finer than common. The only function which the filters have to fulfill is the removal of the suspended iron in the water. The iron remaining in the filtrate corresponds to 14 parts per million of the carbonate. One filter is cleaned daily, which gives it an effective life of but slightly over one week. During the winter this term is extended to about 40 days by breaking up the Schmudzdecke with rakes without removing the water. The time required to scrape one filter and remove the sand is 60 man hours. The sand is washed by passing it with water through revolving drums. The filters of more recent addition are similar to the older ones, except that they are covered, and have a bed of coarse sand from which a higher rate of filtration is secured. It is proposed to increase the time between cleanings by passing the water rapidly through small roughing filters of gravel and small stones before it flows upon the filter proper. The filtered water is pumped directly into the distribution mains.

Wrought iron melts at 3.980 degrees; platinum at 3.080 degrees.

The First National Good Roads Congress

A movement to have the general government of the United States pay at least one-fourth of the cost of constructing and maintaining a permanent system of highways in this country was inaugurated at the first National Good Roads Congress, held in Chicago on June 15. The meeting was held at this time in order that its deliberations might be presented to the National Convention of the Republican party, in an effort to have that party insert a good roads plank in its platform. Another meeting of the Congress will be held at Denver, Colo., on July 6, prior to the convening of the National Convention of the Democratic party in that city. The call for the Congress was issued by the Governors of 34 states, the Mayors of 101 cities and more than 500 residents of Chicago. As showing the interest taken in the movement, 75 members of the Rotary Club of Chicago, headed by its President, Paul P. Harris, attended the meeting.

Delegates from 40 states attended the meeting and addresses were delivered by N. J. Bachelder, former Governor of New Hampshire and Master of the National Grange; Congressman Anthony of Kansas; Martin Dodge, ex-Director U. S. Office of Public Roads; H. H. Gross, Secretary Farmers' Good Roads League, and Timothy Woodruff, former Lieutenant Governor of New York State.

A letter from President Roosevelt, indorsing the movement, was read by Andrew G. Jackson, President of the Congress. President Roosevelt said in part:

"A few years ago it was a matter of humiliation that there should be so little attention paid to our roads, that there should be a willingness not merely to refrain from making good roads but to let the roads that were in existence become worse.

"I cannot too heartily congratulate our people upon the existence of a body such as this, ramifying into every section of the country and bent upon that eminently proper work of making the conditions of life easier and better for the people whom of all others we can least afford to see grow discontented with their lot in life—the people who live in the country districts.

"No one thing can do more to offset the tendency toward an unhealthy growth from the country into the city than the making and keeping of good roads.

"And I am almost tempted to say they are needed for the sake of special conditions in the country districts.

"If a little heavy weather means a stoppage of all communication, you must expect there will be a great many young people of both sexes who will not find farm life attractive.

"It is for this reason that I feel the work you are doing is so pre-eminently one in the interest of the nation as a whole."

The Congress adopted the following resolution:

"Whereas, No permanent system of highways was ever built and maintained in any state or country without the aid of the general government, therefore be it

"Resolved, By the National Good Roads Congress, assembled in the city of Chicago this 15th day of June, 1908, that it is the sense of the Congress that the general government of the United States should pay at least one-fourth of the cost of constructing and maintaining a permanent system of highways."

Catalogs Worth Having.

Engineers and contractors should have on file the latest catalogs of machines, tools and supplies that they use. In sending for catalogs reviewed or advertised in this paper, you will confer a favor on us if you will write direct to the advertisers and state that you saw the catalog mentioned in ENGINEERING-CONTRACTING. If you are in the market for tools, machinery or supplies, tell us and we will notify promptly the leading manufacturers.

No. 0753. **Bitu-Mineral Pavements.**—National Bitumen Co., Indianapolis, Ind.

This 8-page pamphlet presents the merits of the bituminous pavement made by the company named. As described, "Bitu-Mineral pavement is made of a properly constructed base either of concrete or broken stone, on which is laid a wearing surface composed of broken stone of varying sizes, thoroughly coated with the best bituminous cements, and the whole mixed into a homogeneous mass and reduced to the proper degree of solidification by being thoroughly rammed and rolled."

No. 0754. **Road Graders.**—J. D. Adams & Co., Indianapolis, Ind.

This 36-page pamphlet describes a novelty in road graders. The construction of this grader is such that the wheels can be adjusted to any angle with the vertical doing away with side draft and pinching of the wheels. The construction has several advantages which are fully explained by diagrams and text.

No. 0755. **Steel Wagons.**—The Bruner Steel Wagon Co., Wapakoneta, O.

This 31-page pamphlet describes in some detail the construction of the all-steel running gear wagon made by the company named. All parts of the running gear, including wheels, are made of pressed steel, and running gears for all purposes are made. The wagon is unique and the pamphlet has several things to say of its merits which will interest contractors.

No. 0756. **Wells' Lights.**—Wells Light Mfg. Co., New York, N. Y.

The portable, contractors' light, known by the above name, is illustrated and described in this pamphlet, prices are given of complete lights and of repair parts. Besides the use of the light for illumination, its use for burning out lead joints in water pipes, for tire expanding, etc., is also explained.

No. 0757. **Non-Rotating Wire Rope.**—Macomber & Whyte Rope Co., Chicago, Ill.

This 4-page circular describes the effect on wire rope of "spinning" or "rotating," and explains the manner in which this action is prevented by Patent Kilindo non-rotating wire rope. The figures given will interest users of wire rope.

No. 0758. **Engineering Instruments.** —Queen & Co., Philadelphia, Pa.

This small pamphlet is devoted to some of the high grade transit and level instruments made by the above named company for special purposes.

No. 0759. **Wire Rope Tramways and Haulage Equipments.**—A. Leschen & Sons Rope Co., St. Louis, Mo.

In this 24-page pamphlet the company named has given well written descriptions of its various types of wire rope tramways and of its wire rope haulage system for mines. These descriptions give full and concise details of the construction and operation of the several devices.

No. 0760. **Road and Contractors' Machinery.**—The Western Wheeled Scraper Co., Aurora, Ill.

The line of wheeled and drag scrapers, elevating graders, ditchers, rock and ore crushers, dump cars and wagons, etc., made by the company named above are so generally familiar to contractors that they hardly need description. This pamphlet of some 100 pages, however, illustrates and describes the various articles and machines in detail. Specifications, records of work done, special structural and mechanical details are brought out clearly and in a practical manner. Contractors for earth work should secure the pamphlet.

No. 0761. **Wheelbarrows and Carts.**—Syracuse Chilled Plow Co., Syracuse, N. Y.

This 32-page pamphlet lists the dimensions, prices, etc., of a very complete line of wood and iron barrows and hand carts, wheel and drag scrapers, plows and trucks.

No. 0762. **Measuring Tapes and Rules.**—Wiebusch & Hilger, Ltd., New York, N. Y.

This 62-page pamphlet lists the full line of cloth and steel measuring tapes, surveyors' chains, steel rules, straight edges, T-squares, scales and gages made by James Chesterman & Co., Ltd., of England. The several instruments are described and prices, etc., are given.

No. 0763. **Wheelbarrows.**—Withington & Cooley, Jackson, Mich.

This 18-page pamphlet lists the line of wood, steel and combination wheelbarrows made by the company named.

No. 0764. **Waterproofing.**—National Waterproofing Co., 42 E. 23d St., New York.

This pamphlet is a well presented argument advocating paraffin wax as a waterproofing material for concrete, stone and fabrics. Several methods of paraffine treatment are described and discussed.

No. 0765. **Prospecting and Testing Machinery.**—Keystone Driller Co., Beaver Falls, Pa.

A catalog of 112 pages, containing a number of articles reprinted from technical journals on prospecting and testing ground with Keystone drills. Also illustrates machines manufactured by this company, with tools and equipment needed in their operation, with a general price list. This is a very valuable catalog to those interested in testing ground and well drilling.

No. 0766. **Fans for Forced Draft.**—Buffalo Forge Co., 41 Cortlandt St., New York.

A 16-page pamphlet illustrating engines and fans for producing mechanical forced draft for boilers, whereby high stacks are not necessary.

No. 0767. **Contractors' Lights.**—Alexander Milburn Co., Baltimore, Md.

This pamphlet gives information on the construction and use of acetylene gas light for contractors. The simplicity and safety of the gas generator and the quality of the light are especially mentioned.

No. 0768. **Drawing Materials and Engineers' Instruments.**—Kolesch & Co., New York, N. Y.

This 250-page catalog lists a full line of drawing and tracing papers, sun-print papers and equipment, drawing instruments and materials, surveying instruments, etc. It gives descriptions, prices, etc., in such shape as to permit ordering direct from the catalog.

No. 0769. **"American Wire Rope News."**—American Steel & Wire Co., Chicago, Ill.

This issue of the above named monthly bulletin contains several articles of interest to wire rope users as follows: "Different Kinds of Elevators," "Wire Rope on a Battleship," "Wire Rope on the Great Lakes," "Patent Non-Spinning Wire Rope," "Crushing Strains," and "Wire Rope in Stone Quarries."

No. 0770. **Barrows and Carts.**—Kilbourne & Jacobs Mfg. Co., Columbus, O.

This 92-page pamphlet lists a very complete line of cars, scrapers, barrows, carts, wagons and plows. The line of scrapers, both wheel and drag, and of barrows and carts will be particularly interesting to contractors.

No. 0771. **Drawing Materials and Surveying Instruments.**—Eugene Dietzgen Co., Chicago, Ill.

This is an exact duplication of the above named company's large general catalog in pocket size, 4¼x6 ins. It contains 473 pages, listing and giving particulars and prices of all the company's large line of drawing supplies and instruments and engineers' and surveyors' instruments.

No. 0772. **Concrete Block, Brick and Tile Machines and Special Models.**—Northwestern Steel & Wire Works, Eau Claire, Wis.

This pamphlet describes and illustrates several styles of block and brick machines, sidewalk tile machines, silo block machines, sill and cap, molds, column and baluster molds, chimney molds and concrete mixers.

ENGINEERING-CONTRACTING
A Weekly "Methods and Cost" Journal
for Civil Engineers and Contractors.
WITH WHICH ARE COMBINED
ENGINEERING WORLD
and
CONTRACT NEWS
Published every Wednesday by
THE MYRON C. CLARK PUBLISHING CO.
355 Dearborn Street, Chicago
Telephone Harrison 6750
NEW YORK OFFICE: 13-21 Park Row
Telephone 5613 Cortlandt

HALBERT P. GILLETTE . . MANAGING EDITOR
DANIEL J. HAUER, CHAS. S. HILL, C. T. MURRAY, F. A. SMITH, . . ASSOCIATE EDITORS
MYRON C. CLARK . . . . PRESIDENT
A. B. GILBERT . . . . ADVERTISING MANAGER

SUBSCRIPTION RATES (Payable in Advance) —
***$2.00** a year (52 issues) in United States, Cuba, Mexico, Alaska, Hawaii, Guam, Porto Rico, Philippine Islands, Republic of Panama, Canal Zone and Island of Tutuila.*
***$2.50** a year (52 issues) to Dominion of Canada.*
***$3 00** a year (52 issues) to all other countries.*

ADVERTISING RATES sent on application.
Copy for regular advertising must be received not later than Friday preceding date of issue in which it is to appear. "Proposals," "Wants" and "For Sale" announcements can be inserted as late as Tuesday morning.

Entered as second-class matter, April 17, 1907, at the Post Office at Chicago, Illinois, under act of March 3d, 1879.

CONTENTS

EDITORIAL:

What Is a Display Advertisement? What Are Its Uses and Its Limitations? 375
The Conservation of Natural Resources Commenced 375
Engineers Appointed on Commissions for Engineering Work 376

CONCRETE SECTION:

Destruction of Cement Mortar and Concrete by Alkali Salts at Great Falls, Mont., With Discussion of the Effects of Alkali on Portland Cement 376
Concrete Pavement Base Using a Batch Mixer 378
Method and Cost of Constructing a Small Concrete Arch Bridge 378

EARTH AND ROCK SECTION:

The Proper Shape for Rock Drill Bits .379
A Mammoth Clamshell Bucket Having Novel Features 381

GENERAL ARTICLES:

Experiments on Various Types of Fire Hydrants 382

What Is a Display Advertisement? What Are Its Uses and Its Limitations?

As the eighth in this series of articles we come to the subject of the Display Advertisement, as we shall term it.

The drumming advertisement seeks to convince the reader as to the superiority of some particular product. The educational advertisement seeks to interest the reader in a certain class of products by giving valuable information as to the uses of those products. The display advertisement relies neither upon argument nor upon specific useful information to attract attention. It relies upon the display of pictures or words to attract a passing attention to the article advertised, and aims to impress the name of a product or of a manufacturer upon the memory by means of its repeated occurrence in a striking manner.

The display advertisement is the commonest kind of an advertisement. It stares at you in every street car, and it looks back at you from countless billboards as you travel by rail. Popular magazines are soggy with display ads. Although it has become the fashion to ridicule the display ad and to call it ineffective beside the drumming, or "show me" ad, we must remember that scores of firms have made fortunes by display advertising. Certainly, then, it possesses merit. Our opinion is that, if used in moderation, the display style of advertising is an excellent adjunct to the drumming ad and to the educational ad.

There is undoubtedly a class of readers who seldom do more than glance at any advertisement. That class is small, and growing smaller; still it exists, and so long as it does exist, the display ad will be a necessity in any thoroughly effective advertising campaign.

It should be remembered, also, that, when the product advertised is a low priced product, the display ad is apt to be exceedingly effective. For example, nearly all food products are low priced; and a few cents will enable anyone to give a tongue test to the merits of the product whose publicity by display has aroused curiosity. Hence "Wrigley's spearmint" needs little else than clever display of the name to lead thousands to try it. In the engineering field there are many classes of products for which a large demand could be created in the same manner. Lubricating oils, paints, waterproofing compounds, cement, reinforcing steel, and the like, all lend themselves to display advertising. It takes but a few dollars to give these products a test, and clever display publicity will secure the test.

On the other hand, expensive machines cannot be advertised effectively by display ads if supplemented by no other sort of advertising. A man deliberates a long time before choosing an expensive machine, and he must be convinced that it has great merit before he will risk his money on a trial. Hence it is that many advertisers of expensive machines who have aped the toilet soap and breakfast food sort of display advertising lose all faith in advertising in general. Having not reasoned deeply on the subject of advertising, and having tried only one sort of advertisements, they become disgruntled with advertising—and no wonder. They are like the man who dives into Great Salt Lake, and, having nearly strangled in its briny waters, swears that Salt Lake is an unfit place to swim. It is unfit, for that kind of swimming. But, for those who have learned its ways, there is no greater sport than to ride like a cork on its buoyant brine.

A display advertisement need not be changed in every issue; indeed, it is apt to become more effective by a reasonable amount of repetition. This being so, it is wise to spend some money in having an artist get up the illustration that is to form part of it. The tendency among advertisers in engineering periodicals is to use only photographic reproductions, and to use only ordinary type. It is to be hoped that a study of the illustrations and make up of advertisements in the general magazines will lead advertisers in the technical papers to employ skilled men to design their advertisements. Often it happens that an advertiser does not know where to secure a skilled man for such a purpose. Any high class technical paper can furnish the desired information.

As a good example of a well illustrated display ad, we may refer to one that is not now running in any paper, but one that we venture to say has not been forgotten by civil engineers, namely, the advertisement of the E. J. Winslow Co. entitled "Dry as the Desert, Permanent as the Pyramids," in which a desert scene is shown, with camels in the foreground and pyramids in the distance.

Speaking of pyramids, what greater display ads for the Pharaohs than these peaks of stone? The names pyramid and Pharaoh have become so linked together by the oft-repeated pictures of the one and the printed letters of the other that, if one of the Pharaohs could now return and go into contracting for concrete masonry, he would need to do little else than appeal to the public with a picture of a pyramid, his name, and a slogan—I build bulwarks to protect my name against the assaults of the battalioned centuries.

The Conservation of Natural Resources Commenced.

The waste of our natural resources and the immediate need of taking rigorous action to prevent its continuance are matters that have been made familiar by recent discussion to countless persons who previously had given them little thought. Following the notable convention at Washington of Governors of States and United States officials to discuss the conservation of natural resources President Roosevelt appointed a National Conservation Commission to give practical effect to the movement. This commission organized for work during the past week by a meeting of its executive committee composed of one representative of each of the several committees into which the commission is divided. After a brief discussion it was agreed that each committee of the commission should spend the next five months in collecting information to be used when the full commission meets in Washington on

Copyright, 1908, by the Myron C. Clark Publishing Co. All rights of republication reserved.

Dec. 1, 1908. This action takes for the first time the solution of a difficult and important problem out of the realm of possibility and places it in the realm of probability. No one is more concerned in the task before this commission than the engineering-contractor and his support should be liberal and energetic.

Engineers Appointed on Commissions for Engineering Work.

The legislature of New York, which adjourned this spring, passed a bill that the Governor has permitted to become a law, providing for a commission made up of three men, one of whom shall be an engineer experienced in road and bridge building, to have charge of the wagon roads of the State, and be known as the State Highway Commission. Heretofore the State Engineer, through a deputy, has had the supervision of the roads.

The commission is empowered to engage engineers and, besides building new roads, is to maintain those already built. The State is to expend $75,000,000 in highway construction, and there has been $1,000,000 appropriated for yearly repairs and maintenance.

This journal has advocated repeatedly that such commission should be made up of engineers, and we note with great pleasure that the law makes the appointment of one engineer compulsory. It is to be regretted that the bill did not provide that all the members of the commission should be engineers. However, the Governor can rectify this omission by appointing only engineers to membership, the only restriction put upon him being that one member must be from the minority party.

In this connection we are glad to announce that the Governor of Ohio has appointed an engineer to be State Highway Commissioner. Mr. James C. Wonders, the new appointee, during the past 24 years has been the city engineer of Bellefontaine, Ohio, or the county engineer of Logan county. He has also carried on an extensive private practice. During his career he has built more than 500 miles of highways.

New building by-laws recently adopted by the city of Manchester, England, provide among other things, that in future no new street will be less than 14 yds. wide, an increase of 2 yds. on the minimum width. Main roads must be 50 ft. wide instead of 36 ft., the present minimum. And, as far as possible, one street will be planned so as to fit in with other streets. Long rows of houses, all of one pattern, will not be sanctioned. No block of houses must contain more than 10, nor cover a frontage of more than 100 yds. At the back of each cottage there must be an area of not less than 250 ft., an advance of 100 ft. No blind alleys will be allowed in future, and all passages must lead to main streets.

Concrete and Reinforced Concrete Section

Note: This Section is devoted to methods and costs of constructing concrete and reinforced concrete structures. It will cover the selection, testing and proportioning of concrete materials; laboratory tests of concrete; concrete mixing, transportation and placing; fabrication and placing of reinforcement, and form construction and erection. It will also contain articles on new and interesting developments in the design of reinforced concrete.

Destruction of Cement Mortar and Concrete by Alkali Salts at Great Falls, Mont., With Discussion of the Effect of Alkali on Portland Cement.

Cement pipe sewers and cement mortar in brick sewers at Great Falls, Mont., have suffered serious damage presumably from the action of alkali salts in the soil and the trouble is being investigated by the Chemistry Department of the Montana Agricultural College Experiment Station. A preliminary report of the results of these investigations have recently been made by Mr. E. T. Tannatt, Rural Engineer, and Mr. Edmund Burke, Chemist, of the station.

Briefly stated, oval shaped cement pipe sewer, 26x32 ins., laid at Great Falls in 1890, shows defects so serious that portions will have to be rebuilt. The remaining portions also show more or less serious disintegration. Also brick sewer with cement mortar joints and outside plastering of cement is similarly going to pieces from disintegration of the mortar. These conditions led to the investigations noted above with the results given as follows in this report:

Sixth Street Sewer.—This sewer is for a combined system and is circular in form, 4 ft. internal diameter, constructed of two layers of brick laid on end and in Portland cement mortar. The exterior surface of the sewer is covered with a ½-in. cement plaster coat.

The sewer was constructed in 1893 and was made of Montana brick. The mortar in which the brick were laid being made of river sand, and Portland cement in proportion of one part of cement to three parts of sand. The city engineer advises us that no free lime was used in the construction and that the cement showed good tests for tensile strength.

At the intersection of each alley, manholes were provided. These manholes were constructed in the usual form, and of the same brick and mortar as the balance of the sewer.

In making an examination of the sewer we found as follows:

Certain portions of the sewer showed the presence of external moisture to a more marked degree than other sections. The interior of the sewer in all parts, and in the manholes, showed along the cement joints and along the edges of the cement patches, a white efflorescence, or powder. Samples of this powder were taken and analyzed and found to be white alkali, as per analysis, Table I.

We found the brick to be the usual soft brick of the state and not well suited to sewer construction. We were not surprised, therefore, to find the brick showing the action of moisture, and in places where the brick were unusually soft, a very serious disintegration had taken place.

Examination was made of the cement mortar in which the brick were laid. This we found in many places to be of the consistency of fresh lime mortar, although in spots the mortar was in apparent good condition and made of an apparently good grade of cement. The mortar first referred to could be removed readily with a knife blade or finger nail. We noted particularly that where the white deposit above referred to was largest, that there we found the destruction of the cement mortar the most pronounced.

We further found that the arch of the culvert had suffered less from the destructive action than the invert. The strongest action was noted on the sides of the sewer, below the center line and above the average water mark of the sewage, although we were advised that much of the bottom of the invert had been removed and repaired since the original construction. We also noticed that where exterior moisture was most apparent that at that point the destructive action had made greatest progress. This action we found had progressed so far in some parts of the sewer as to require the removal of the brick and the re-setting same in fresh cement mortar. In many places even the new cement mortar had undergone disintegration to a marked degree.

The sides of the manhole, even above the highest point reached by the sewage, we found to be covered with the white powder and the same destruction of the cement had occurred.

From an examination of the sewer we became convinced of the following facts:

First—That the disintegration and destructive action of the cement did not come from adulteration of the cement, nor from the quality of materials used.

Second—Although it is possible that a limited chemical or physical action of the alkali salts may be a partial cause of the breaking down of the brick, yet the principal cause of the failure of same is chargeable to the fact that the brick used were too soft and not fit for sewer construction.

Third—That the action upon the cement was chemical action, and that the destructive agent came from the outside of the sewer, and the disintegration of the cement cannot be charged to any action arising from the sewage, or gases from same.

Having reached the above conclusions, we proceeded to ascertain the cause of the difficulty. Samples of the mortar, in various stages of decomposition were taken, also of the white powder. Holes were driven through the cylinder of the sewer and samples of the back filling against the brick were taken. Along the line of the sewer and at various distances from same, auger holes were driven from the surface of the ground and samples of the soil were taken. Samples of the soil of a character in which the city engineer had noted greatest activity were taken from adjoining excavations. This soil is a heavy, lead-colored, dense clay, strongly impregnated with alkali, and is locally known as gumbo. A description of these several samples and anaylsis of same is given below.

Third Street Sewer—This sewer is constructed of cement pipe, is oval in shape, with dimensions 26x32 inches. The size of the sewer, together with the fact that considerable sewage was flowing at the time, prevented our making an extensive examination of the entire sewer, although sufficient of the same was examined to convince us of its condition. We were not, however, inclined to make very extensive examinations, as we found the cement so badly decomposed that we could easily remove handfulls of the pipe with the naked hands. The cement pipe was little better than compressed sand held in place by the arched form.

In the manholes we noted the same white efflorescence as in the Sixth street sewer. Samples of the disintegrated cement pipe were taken, as also the white powder. From examination made of the decomposed cement pipe, above referred to, it was found that the cement had been almost entirely removed from the same, and that little more than pure sand remained. This sewer is virtually destroyed, so far as cement construction is concerned, at least in the sections examined.

As the gumbo, which carries the larger percentage of alkali, is highly impervious to water, and has proven extremely difficult to filter in our laboratories, it is hard to imagine how alkali can be deposited from and through such materials. We, however, found that along the sewers in question, and especially in the adjoining lots, were low places in which water annually collected. Some of these depressions were made by the construction of the street at a grade higher than the level of the lot. These low places were largely in the gumbo, and until drained by the City Engineer, for sanitary reasons, formed ponds from which the water very gradually seeped into the earth. Upon examination we came to the opinion that the depressions above referred to, as well as other depressions, both on the surface and in the formations themselves, together with the exposed surfaces in adjoining formations, offer a means whereby the alkali is leached from the gumbo. This alkali-bearing water passing through the sand and more permeable formations reaches the back filling, there to deposit the alkali against the outside of the sewer. As this water must find an outlet through the sewer itself, or the back filling, it is held in a position to indefinitely continue its destructive action. We also found that the samples showing highest percentages of alkali were those taken immediately back of the cylinder of the sewer.

The samples of soil were taken after a careful examination of the sewer, and were secured with the purpose of ascertaining the following points:

First—To ascertain the amount of alkali salts in the soil immediately adjoining the sewer, where the least average and greatest destructive action was noted.

Second—To ascertain if the alkali was being leached from soils drained by the sewer and borne by the ground waters to the back filling of the sewer.

Third—To ascertain the percentages of alkali in soil not adjacent to the sewer, yet drained to same.

Fourth—To ascertain the percentages of alkali at various depths in soils adjacent to the sewer, yet not immediately in contact with same.

All of the samples were taken with a 1-in. auger, and each foot from the surface represents a numbered sample, as shown in Table I.

TABLE I—PERCENTAGES OF ALKALI IN SOILS.

Lab.No.	Sodium Sulphate.	Sodium Carbonate.	Sodium Chloride.	Depth
		Series No. I.		
4547	.565	.021	.0256	6-foot
4548	1.239	.008	.0387	7-foot
4549	.781	.021	.0323	8-foot
		Series No. II.		
4550	.611	.027	.0323	4-foot
4551	.473	.036	.0288	5-foot
4552	.899	.021	.0224	6-foot
4553	.851	.032	.0288	7-foot
4554	.738	.023	.0323	8-foot
4555	.539	.025	.0288	9-foot
		Series No. III.		
4556	.860	.027	.0358	2-foot
4557	.525	.025	.0323	3-foot
4558	.397	.027	.0272	4-foot
4559	.199	.028	.0192	5-foot
4560	.065	.001	.0192	6-foot
4561	.200	.005	.0418	7-foot
		Series No. IV.		
4567	.239	.042	.0192	
4568	.510	.028	.0192	
4569	.696	.047	.0224	
4570	1.028	.034	.0323	
4571	.091	.028	.0224	
		Series No. V.		
4564	3.641	.012	.0448	
4565	2.901	.012	.0768	

TABLE II—ANALYSES SHOWING THE COMPOSITION OF ALKALI AT GREAT FALLS.

Lab. No.	4543
Silicia	.110
Calcium sulphate	4.840
Magnesium sulphate	23.830
Potassium sulphate	0.540
Sodium sulphate	59.670
Sodium nitrate	.000
Sodium chloride	7.860
Sodium carbonate	3.130

Cause of Disintegration of Cement—In examination of the above analyses we call attention to the fact that where maximum disintegration of the sewer occurs, that there we find the greatest percentage of alkali, and that the amount of disintegration corresponds closely to the percentage of alkali present. The tabulation also indicates that the ground waters are leaching the alkali from the soils and depositing the salts along the barrel of the sewer.

So far as we know, this is the first time that the attention of the public has been called to the action of the alkali of the soils upon Portland cement.

Just how the alkali in the soil acts upon the cement is a matter for investigation. It is possible that the action is similar to the action of the salts in sea water, as quoted above, or it may be that the cements behave in a manner similar to the soils containing zeolites. Zeolites being hydro-silicates containing as bases chiefly lime and alumina with some potash and soda, and which have the power of absorbing alkali salts and exchanging bases with them.

In the use of concrete for sewers in alkali sections and other cement construction, we feel that our investigations undoubtedly point to the fact that the use of cement is inadvisable where it is not possible to drain all ground waters from the exterior of the sewer. Where the sewer will be below the level of the groundwater service, even for a portion of the year, we believe that the chemical action of the alkali will eventually destroy the construction. The action will be specially destructive in event reinforced concrete is used. Where the sewer is above the general ground water level, we would recommend the sub-draining of the sewer.

In this construction drain tile should be placed in the bottom of the trench and the same covered to a sufficient depth with clean gravel or crushed stone; the sewer laid on this foundation and a sufficient thickness of clean gravel, or crushed rock placed around the barrel of the sewer to afford drainage to the tile, of all seepage water entering the back filling. One or two sets of drain tile could be used, a single line of tile under the center of the sewer, or two lines of tile at corners of the excavation. In recommending this system we feel that the object to be accomplished is the removal of the ground waters before they can come in contact with the sewer. Where the ground waters cannot be thus removed, we would, from our investigations thus far conducted, unhesitatingly recommend that cement pipe be not used.

The Interstate Commerce Commission has notified all railroads that tariffs must be printed on paper 8x11 ins., and if any other size is used they will not be accepted.

Concrete Pavement Base Construction Using a Batch Mixer.

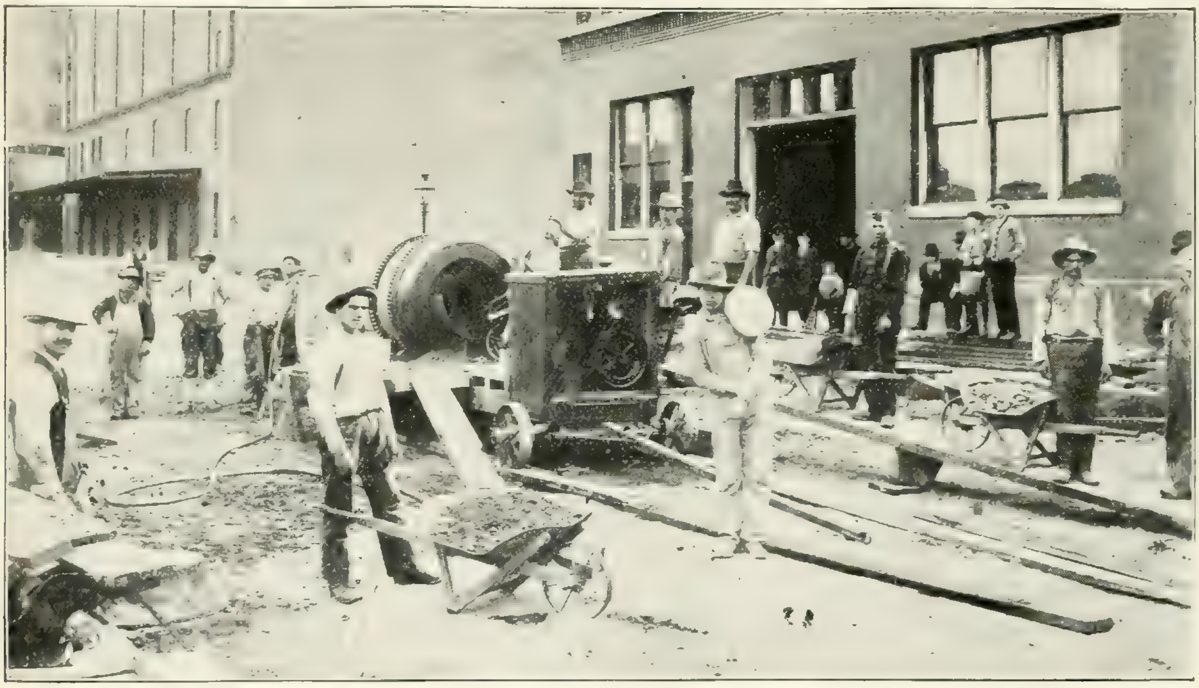
The work was done in Chicago on a street 26 ft. wide between curbs, the foundation being 6 ins. thick of 1-3-6 Portland cement broken stone concrete. The sand stock pile was continuous along one mile of the street inside curb and the stone stock pile continuous along the other side of the street. The cement stock pile was located on one sidewalk about the middle of the block. The mixer was mounted on trucks and backed away from the work. A ½ cu. yd. Cropp mixer sold by the Standard Scale & Supply Co., Chicago, Ill., was used. It was operated by a 3½ H. P. air cooled gasoline engine and weighed on trucks, including engine, 2,100 lbs. It was readily pulled by hand, including charging platform. This platform was built across machine between engine and mixer drum and was 24 ins. high. Incline runways, one for loaded and one for empty barrows, led to the platform from the stock piles at the rear. A cement box on legs was set close against the forward edge of the platform, and to one side of the mixing drum. A third runway for the man wheeling cement led to the platform close alongside the cement box. Planks were put down to serve as a track for hauling the mixer.

As stated, the mixer was moved by hand. As the concrete was taken away by shovels, short moves were made to reduce carrying. About 10 to 12 ft. was the usual move, and it was accomplished very quickly; several moves were timed and averaged less than one minute each from the time the running boards were taken down until they were in place again. The mixer was not stopped during moving. The gang showed good discipline in making the shift and this accounted largely for the quick work and lack of confusion.

The mixer discharged onto a sheet iron "shoveling board" laid on the ground, and from this the concrete was cast and carried into place in the foundation. One man tended the discharge, six men took the concrete away with shovels, one man aided in spreading and two men tamped and swept the concrete. On the mixer one man added the water and watched the charging and one man charged the cement, dipping it from the cement box into a special hand scoop bucket used for charging. The man wheeling cement untied the bags and emptied them into the cement box. The stone was wheeled by six men and the sand by three men. In addition there were four men setting stakes and doing other necessary work on the job. The total working gang was thus 26 men and a foreman.

A 9-hour day was worked and an average of 725 sq. yds. of 6-in. pavement base was laid per day. This is about 121 cu. yds. of concrete in place per 9-hour day with a ½ cu. yd. mixer. Assuming an average wage of $2 per day, the labor cost of the foundation in place was 27×$2=$54÷725 sq. yds=7.45 cts., or say 7½ cts. per sq. yd. or 45 cts. per cu. yd. of concrete. It should be noted that the men were well handled and worked at a lively pace.

The accompanying illustration is a view of the work looking toward the rear or charging end of the mixing plant. We are indebted for this cut and for the opportunity to gather the information given above to the Standard Scale & Supply Co. of Chicago, Ill., which handles the Cropp concrete mixer.



View of Work Looking Toward Charging End of Mixer.

Method and Cost of Constructing a Small Concrete Arch Bridge.

The bridge carries O'Connor St., Ottawa, Ont., over Patterson's Creek. It was constructed under the direction of Mr. R. H. Parsons, Assistant City Engineer, who furnishes the following discription and figures of cost:

The principal dimensions are as follows: Span, 20 ft.; length, 46 ft.; rise, 4 ft. 10 ins.; thickness of abutment at springing line, 5 ft. 6 ins.; thickness of arch ring at crown, 18 ins. The arch is built on a skew of 17°. The arch ring is reinforced with Clinton electrically welded fabric, with 3x12-in. meshes and ⅜-in. gage. The reinforcement was placed about 3 ins. above the under surface of the arch at the crown, and is firmly anchored in the abutments by steel rails. The crown of the arch is about 8 ft. above water level when the water is in the canal. There are four wing walls.

The bed of the creek was excavated until a solid foundation was reached, and on this the forms for the abutments were erected. Considerable trouble was caused by the water from the melting ice and snow, which ran into the trenches, and necessitated pumping until the concrete was above the level of the creek bed.

The concrete was mixed in the proportion of 1-3-7 for the main part of the abutment with a fine mixture, 1-2-5 about 1 in. thick for a facing. The concrete in the arch ring was mixed 1-2-5. The abutments were both brought up to the springing line of the arch and sloped upwards towards the back to form a shoulder for the arch to rest against. The arch itself was built in rings about 10 ft. wide. Work was carried on continuously on each ring until it was complete. A 3-in. layer of concrete was spread over the forms, which had been previously erected, then the Clinton fabric was laid down on this and fastened to the rails in the abutments. The rest of the concrete was then placed in 6-in. layers up to the required thickness. The top of the arch was plastered with cement mortar to make it water tight. In the coping on the parapet walls iron rods were inserted in the proper places to tie the concrete posts for the railing to the coping. The rails were molded in separate forms, and are 3 ins. x 9 ins., and about 9 ft. 6 ins. long. There are two ⅜-in. iron bars about 1 in. above the bottom of each of them. After the rails had set for a sufficient length of time the forms for the posts were set up, the rails taken out of their forms and the ends inserted in openings cut in the post-molds in the proper places. These were then filled with concrete and allowed to stand several days before the forms were removed. Very little finishing was needed to give the railing a pleasing appearance.

The work was started about April 1, 1907, and was completed six weeks later. There was considerable delay on account of bad weather.

The wages paid were per 9-hour day: Foreman, $3.50; carpenters, $3.15, and laborers, $1.75. The price of lumber was as follows, per 1,000 ft. B. M.: 1x10-in. pine, $18.50; 1¼x4-in. spruce, dressed and matched for exposed surfaces, $30; 2x4-in. spruce scantling, $25, and 2x6-in. spruce, $25. There were 620 cu. yds. of concrete in the bridge, of which 92 cu. yds. in the arch were reinforced. The cost of the work was as follows:

Forms and center—	Total.	Per Cu.Yd.
Labor	$ 397	$0.645
Materials	575	0.930
Total	$ 972	$1.575
Concrete—		
Labor	$ 849	$1.37
Materials	2,608	4.20
Total	$3,457	$5.570
Excavation	395	0.565
Total, exclusive of reinforcement	$3,852	$7.710

The cost of reinforced concrete in the arch was:

92 cu. yds. concrete	$7.71
Reinforcement ($192 for 92 cu. yds.)	2.09
Total	$9.80

A resolution before the Canadian House of Commons provides for the organization of a department of public health, whereby all matters in connection with the health of the dominion would be consolidated under one responsible head, instead of, as at present, being scattered through five or six other departments.

Earth and Rock Section

Note: This Section is devoted to methods and costs of excavating earth and rock and building embankments. It will cover the grading of roads and railroads, diking and canal work, dredging, building reservoirs and earth dams, sewer and water pipe trenching, quarrying, etc.

The Proper Shape for Rock Drill Bits.*

BY D. J. O'ROURKE.†

Much attention is paid to the mechanical details of drilling machines at the time of their purchase, to secure those which will be most efficient in the amount of power used and in cost for maintenance. Too often, this is as far as the user's interest goes. Having procured a good drill, he does not take steps to secure the very best working efficiency from it.

The question of drill steel, its selection, care, and use, is one which is given far too little attention, and which in many cases is the determining factor as to the economic success of a drilling plant. If the steels are of good materials, carefuly made, sharpened and tempered for the work to be done, and if fresh steels are put into use as soon as the gage begins to wear, the drills will come up to expectations as to speed and efficiency; but if the blacksmith is incompetent and the drill runner careless, the management could better afford to throw out its machines and go back to hand drilling.

The Blacksmith.—The blacksmith's work should be recognized as almost equal in importance to that of the master mechanic at a drilling plant. The best smith is none too good, even if there should not be enough work to justify the wages he may demand. It is cheaper to have a blacksmith and helper idle once in a while than to have two or three drill runners and their helpers standing around watching the drills wearing themselves to pieces, and perhaps helping them along with a sledge hammer, while the drills fail to give results, merely because the bits are not right. There are also other men on the premises shoveling away dollars in the shape of coal, and this too must be taken into account. When it is all summed up, the idle time of the blacksmith and helper is an insignificant item.

When a new compressor plant is installed, every feature, whereby a pound of coal or an extra foot of air may be saved or made is investigated, and every precaution taken to secure economical results. After the plant is running, the drilling, which was at all times the main object, is sometimes allowed to run along in such a way that anywhere from 10 to 50 per cent of the power developed is completely lost. No one would think of allowing a hoisting engine to hoist a load with the brakes partially set, but something similar occurs when a rock-drill bit is run so long that it is the same gage for an inch or more back of its cutting edge, or is allowed to be made with shoulders on it in the first place.

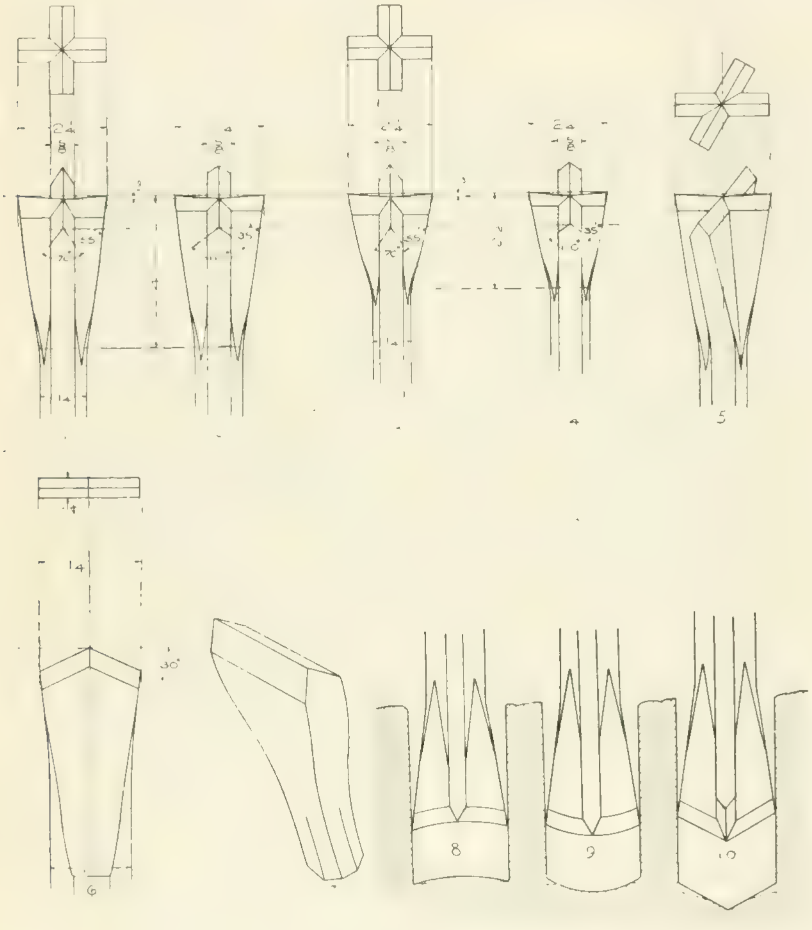
Shape of the Bit.—For drilling rock of any kind, the cross-bit, made like Figs. 1, 2, 3 and 4, sometimes modified to the X shape shown in Fig. 5, is usually employed. It will be observed that the bits above referred to are made concave with the corners of the wings ahead of the center. This design is recommended because used bits show very little wear at the center as compared with their outer edges. This indicates that the corners do the largest part of the work. The cutting done by them so weakens the rock toward the center of the hole that it does not afford so much resistance to the center of the bit.

Figures 8, 9, and 10 show what actually takes place in fracturing the rock with bits of several shapes. Figure 8 shows the concave bit, whose corners cut ahead of the center, making the line of breakage very weak and leaving little resistance for the center of the bit, as described above. Figure 9 illustrates a convex bit. In this, the center has to cut ahead of the corners. The fracture line is thus divided, leaving but little work for the corners to do. The cross shape of the center, together with the increased amount of work which falls upon it, in this case, greatly retards its cutting efficiency. Figure 10, the diamond-pointed bit, also divides the fracture line, but at the same time increases its length, leaving less cutting for the center. With this bit, the rock tends to break to a flatter angle than the angle of the bit, allowing the center to go in advance of the corners for a few blows, when the entire bit again comes in contact with the rock, fracture again takes place, and the process described above is repeated. This bit is recommended only for marble, soft limestone, and other even, soft rocks. Its advantage for this work lies in the fact that nearly all drilling in quarries is done on laid-out lines, so that this form enables the holes to be started accurately. The bit, however, is made very thin and is not strong enough to be satisfactory on general mining and contract work. The flat, or "bull" bit, as it is sometimes called, shown by Fig. 7, is made in various shapes, but no matter how it is made its use is very severe on a rock drill. If thin, it has no reaming qualities; if made heavy, as it generally is, the blow delivered imparts a severe jar to the machine. The flat bit, with diamond point, Fig. 6, is a style which has been used in marble quarries from the earliest introduction of the rock drill. The steam pressure used in those days was considerably lower than now, so that this bit was satisfactory, and cut slow enough to ream the holes fairly well. Even under these conditions it was hard on the rotating device, but when higher pressures were introduced its cutting capacity was increased, while its reaming qualities remained the same. The flat bit may cut more rapidly for a short time, but in the long run the cross will be found more economical. The use of the X bit, Fig. 5, is not general, but sometimes is desirable when a cross-bit will persist in drilling "rifled" or five-fluted holes on rock of some kinds. Sometimes rifling is charged to the machine, but the fact that the X bit is not required on all kinds of rock rather disproves this imputation.

---

*Reprinted from Mine and Quarry

†Claremont, N. H.



Sketches Showing Shapes of Rock Drill Bits.

Sharpening the Bits.—Figures 1 and 2 are bits for hard, non-gritty rock, and are alike except for the different angles shown on the cutting edges. Figure 1 shows about the highest angle to which the cutting edge can be made without danger of breaking. The angle shown on the cutting edge in Fig. 2 is one of many which may be used under different conditions, without any change in the bit. In cutting hard and medium hard rock, sharp drills and a wide-open throttle may be used to good advantage, and the hole will not ordinarily clog with mud, as the amount of rock loosened by each blow is so little that it is at once mixed into slush by the water in the hole. The sharp rebound of the drill when striking hard rock, together with the positive recovery of the machine, quickly gets rid of this slush. If the same bits and drill are run on an open throttle in soft or even medium soft ground, the hole soon becomes clogged. The reason for this is that while the hole remains of the same diameter, and the amount of water for mudding purposes is therefore the same, the steel chips out three or four times as much dust at each blow as it does in hard rock. The rate of cutting should therefore be reduced in order to keep the drill working at maximum efficiency. The speed may be regulated by throttling the air or steam, but this reduces the rapidity of action of the drill, so that it does not always mix into slush the dust caused at even the slower speed. The recoil of the steel from soft rock is also considerably less. In soft rock duller bits should be used, like that shown in Fig. 4. The angle of the cutting edge may be even higher than this, sometimes almost square on the end, in order to secure good results.

Length of Up-Set.—In connection with the above subject, it is well to bear in mind the length of the wings or ribs for different kinds of work. Figures 1 and 2 show an extreme length for very hard rock, intended to give strength and hold the gage as long as it is necessary. Figures 3 and 4 show shorter ribs which give the bit more clearance and make it more desirable for general purposes. Under ordinary conditions its ability to mix mud is much greater than that of the long bit like Fig. 1. This shortness gives greater flare to the wings, causing a greater backward thrust to be given the cuttings, whether wet or dry. In rock which wears the gage rapidly, however, the up-set should be longer. For drilling dry holes in tunnel headings or elsewhere the bit with short ribs has less tendency to allow the hole to draw up. The friction of this style of bit retards the machine but little, and will cause it to cut down toward the lower side of the hole, thereby straightening it. If this is done in time, it saves frequent drops of the arm and keeps the hole where it is wanted. It will be found on experiment that such results cannot be gotten if a long bit with very slight clearance is used. The wings are five-eighths of an inch thick for the size shown in Figs. 1 to 4, and should never be less than that for this size of bit and steel. They should be the same thickness throughout to allow free return of the cuttings. If gage less than two and one-quarter inches is desired, make the bit correspondingly shorter.

Gage.—It should be especially noted that in all the sketches the outer edges of the wings are square. This feature is very important, to preserve the gage of the hole. Whether the bits are sharpened by machine or by hand, care should be taken that no bits are made with the outside edges made rounding like a Fig. 8. The question of maintaining the gage of the hole throughout its length is very important. It should be carefully determined just how much work each drill bit will do before the gage begins to wear. In the hardest rocks a bit is never in condition to use the second time, and from 24 ins. to 30 ins., depending on the length of the feed, is all that is ever attempted. Sufficient steel is therefore supplied, so that a sharp set is on hand for each hole. In softer rock and ore it frequently happens that the steel will not become dull even if used on several holes. Drill runners are, therefore, apt to disregard the question of the gage so long as the cutting edge is sharp. The gage, however, causes the rub in more than one sense. This is where the rub comes in that retards the work of the drills, shortens their life, consumes power, and increases the repair bills. For example, on this kind of rock a runner is given two sets of sharp steel to drill a required depth. Each set will drill perhaps two holes each without making trouble. About the third hole on which this steel is used the bits stick and there is a constant demand for a hammer or a chuck wrench with which to beat the steel, and if the right point of humor is reached there is no discrimination shown between the steel and drill piston. Here is a drill that worked all right on the first hole, fairly well on the second, and will not work at all on the third. The rock is the same and the drill is the same, but not so the bits. The only sharp bit that can be gotten into that hole must be made specially in the blacksmith shop half a mile away, so the hammering is kept up and the drill finally worked down somehow, taking usually more time than it took to put in the first two.

When the gage wears so that a new steel is needed in order to insure its following the last, an entirely new set should be used. It makes no difference if one of the bits still appears good, for it is economical not to waste time with it. On any rock on which the cutting edges are not dulled upon the first hole, a system should be devised by the foreman or superintendent to determine how much each bit will do without too much "hammer help." The improvement will be very pronounced. The runner or blacksmith should have nothing to say as to this system. The blacksmith should have rigid instructions to furnish all bits to the exact gage required, so that the new bits will work freely when placed in the hole. Much time is wasted from the fact that bits are not made exactly to gage to begin with.

Users of mechanical drill sharpeners are advised to give thought and care to securing the proper dies and dollies to make bits suitable to the conditions under which they are to be used; also that when drills are being dollied the dies do not open. Some rather impossible-looking bits are occasionally seen for this reason alone.

Temper.—The matter of tempering bits is another point in which the blacksmith can save or waste much drilling time to his employers. A competent blacksmith will furnish bits of the precise temper, to suit the rock being drilled.

A Mammoth Clamshell Bucket Having Novel Features.

The largest clam-shell coal bucket ever built in New York possesses interest not merely because of its largeness, although that in itself is worthy of consideration.

A clam-shell that weighs nine tons and has a capacity of 7½ cu. yds., water measure, is shown in Figs. 1 and 2. This bucket is designed to handle coal from stock piles, feeding the coal into a Robins belt conveyor, at the plant of the Illinois Steel Co., Joliet, Ill. The bucket will be handled on a horizontal cantilever bridge, and will be so counterweighted that only a small amount of power will be required to operate it.

One of the striking features of the bucket is the design of the side chains, by means of which the bucket is closed. When these chains are wound upon the power shaft, two full turns are made upon the shaft, yet the design of the chain is such that it does not wind upon itself, nor does it wrap about the shaft after the fashion of a rope winding upon a drum in successive strands. Fig. 1 shows that the upper half of the chain is made in two parts, and the lower half is made in three parts. When the chain winds upon the power shaft, the "two parts" fit in between the "three parts," so that they all lie perfectly parallel upon the shaft. Thus all side crowding and overlapping is done away with entirely, and there is complete protection again "chain troubles." This ingenious solution of the winding problem is one that is now applied to all sizes of Hayward clam-shell buckets.

A word or two now about the general design of this mammoth bucket.

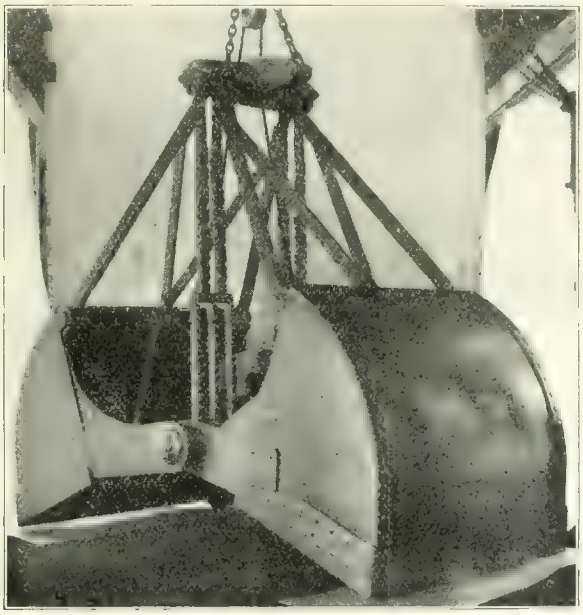


Fig. 1.

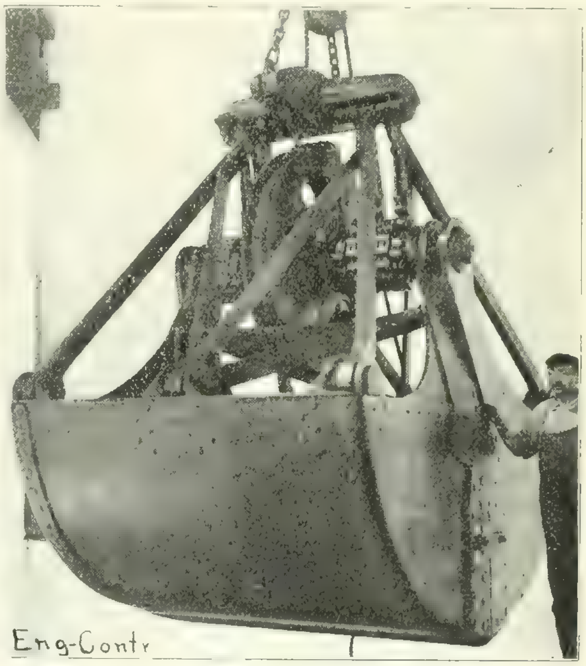


Fig. 2.

When closed the bucket is 12½ ft. high. It measures 7 ft. along the cutting edge of the bucket, and the distance between the jaws is 1 ft. when open. The power shaft is 5 ins. diameter, and the power wheel is 56 ins. in diameter. The nut on the power shaft alone weighs 40 lbs.

No angle irons are used in the construction of the bucket, but the sheets of open-hearth steel are bent to form the angles. The two main castings are of iron, and the minor castings are of bronze and steel. Steam hammer forgings are used throughout. A simple system of diagonal bracing gives great rigidity and strength.

As above stated, the capacity of the bucket is 7½ cu. yds., or 5 tons of coal, water measure, but the ordinary heaped load will be approximately 6 tons.

This bucket was manufactured by The Hayward Co., 50 Church St., New York City, to whom we are indebted for the photographs and the data from which this article was prepared.

According to a recent consular report the measure passed by the Calcutta (India) council for the erection of a steel tank to cost $2,305,958 has been approved by the lieutenant governor of Bengal, and proposals for bids for its construction will doubtless be issued very soon.

The grand total of excavation on the isthmian canal during the month of May was 2,703,923 cu. yds., all of which, except 177,673 cu. yds., was taken from the canal prism.

The Italian state railways have decided to adopt liquid fuel on some of the mountain lines with long tunnels.

Unclassified and General Articles

Note: This section is devoted to methods and cost articles on construction work not properly coming under any of the preceding classifications.

Experiments on Various Types of Fire Hydrants.*

BY CHARLES L. NEWCOMB.

The object of these tests was a complete investigation of the fire hydrants now commonly used, and the work was divided into the following classes:

1. The loss of pressure due to the friction of water in the hydrant, the total loss being subdivided into barrel loss and nozzle loss.

2. The discharging capacity of open hydrant butts at different pressures.

A few tests on several different hydrants were made in 1886 by Prof. Selim H. Peabody, of the University of Illinois. The results of these were not entirely satisfactory. Mr John R. Freeman, in his "Hydraulics of Fire Streams,"† gives a table the discharge of one open butt of a four-way independent gate hydrant at various pressures and some percentage corrections when using the table for other types of hydrants. Beyond these tests the writer has been unable to find anything of importance, though diligent inquiry was made. In the experiments here described it was possible to test a large number of hydrants under widely varying conditions, and the aim has been to bring out results which would be of value to hydraulic engineers and hydrant manufacturers.

The hydrants were in part bought from the manufacturers and in part loaned by them. In all cases it was fully explained that the hydrants were to be used in extensive tests and that the usual commercial article was desired. The cheerful co-operation of the manufacturers was of material help throughout the experiments.

. The mercury gages and the meter nozzle were loaned by the inspection department of the Factory Mutuals. The Trident meter was loaned through the kindness of the Neptune Meter Co. The Worthington meter was purchased specially for the work.

The water for the tests was drawn from the city mains, an 8-in. pipe being laid into the basement for this work. The city is supplied by gravity from reservoirs, and the pressure was generally quite steady. The mains were of such size that all water needed could be obtained at good pressure. The 8-in. main was provided with a gate just inside the building. It then connected with a 6-in. Worthington meter. A short length of pipe connected the meter to a manifold with six outlets. To each outlet was attached a 6-in. gate, and each hydrant connected with a gate by a short length of 6-in pipe.

Piezometers.—About 2 ft. from the inlet of the hydrant a hole for ¾-in. pipe was drilled in the cast-iron pipe and tapped. Into this hole a short nipple with a stopcock was screwed, from which connections were taken for the gages. This connection served in place of a regular piezometer and can be relied upon to give sufficiently accurate results, as the velocities were not high and there were several feet of straight pipe back of the hole, so that a uniform condition of flow might be expected. Care was taken to drill the hole at right angles to the pipe and to prevent the gage connection from extending into the pipe. Care was also taken to remove any burr made in drilling. If either of these points had been neglected a false reading would have been the result.

A ¼-in. hole was tapped into the back of the hydrant about on a level with the nozzles, and a connection screwed in with the same care as for the 6-in. pipe. To the 2½-in. hydrant outlets special piezometers were attached. The circular space extended around the piezometer and connected with the interior by four ⅛-in. holes drilled at right angles to the axis of the bore. The pipe leading to the gages was connected to this space between two of the holes. This arrangement materially assists in the accurate determination of the pressure when the velocity is high and the water is likely to be in eddies, as would be the case at the outlet of a hydrant. At the end of the piezometer a 50-ft. line of ordinary 2½-in. cotton, rubber-lined, jacketed fire hose, loaned by the Fire Department, was attached, which conducted the water to a meter nozzle located in the yard. When two outlets were in use two lines of hose were employed, and for the three or four-way hydrants three and four lines were used. With two lines of hose two piezometers were used and connected together by a short length of ¼-in. pipe. The connection for the U-gage was taken from about the middle of this pipe. When using more than two streams only two piezometers were used, it being assumed that the average pressure was fairly well secured in this way without the use of a piezometer on each outlet.

Meter Nozzle.—The meter nozzle was one designed by Mr. John R. Freeman for accurate water measurement. The three-way connection joints a 3¾-in. piezometer made on the same principle as the 2½-in. piezometer. To the end of the piezometer nozzles from ½-in. to 2½-in bore can be screwed. When using four streams an ordinary Siamese connection was screwed to one of the inlets. For the six streams in the tests of the six-way hydrant, the fifth and sixth lines were run separately and each provided with an Underwriter play pipe. At the base of one play pipe was a 2½-in. piezometer, which was connected to the mercury column and turned on alternately with the meter nozzle.

With the pressure at the nozzle piezometer accurately known the quantity of water can be readily computed. In all the friction loss tests the quantities were determined by the nozzles rather than by the meter. The Worthington meter gave trouble from its pulsations affecting the gages, so that a by-pass connection was put in and the meter abandoned. Later the Neptune meter was put into this connection and used for the last part of the open-butt tests.

Gages.—The nozzle pressures were measured by a mercury column with a scale graduated to read pounds and tenths of a pound directly, and to include a connection for the lowering of the surface of the mercury in the cistern. The gage was connected to the nozzle piezometer by ¼-in. iron pipe and rubber tubing, care being taken to have the joints practically tight. The pipe sloped upwards from the nozzle, and a blow-off cock was placed at the highest point so that all air in the connections could be surely blown out. The gage was set up against the rear brick wall of the building, and the tube extended into the second story of the shop through a hole in the floor.

Losses of pressure were measured between the 6-in. inlet and the connection at the top of the hydrant; also between the 6-in. inlet and the 2½-in. piezometer. Thus the first gave the barrel loss and the second the total loss. The difference was then the nozzle loss. These losses were measured directly on a U-tube mercury gage. For this gage a heavy glass tube with an inside diameter of about ¼ in. was bent into the shape of a U with one leg about twice the length of the other. The tube was filled with mercury nearly to the top of the shorter leg. A short length of rubber tube was cemented to the top of each leg. This tube connected the glass to a fitting made up of ordinary ¼-in. pipe and containing stop-cocks and a blow-off cock for air. From these fittings connections of ¼-in. pipe or of rubber hose were taken to the points in the hydrants between which the loss was desired. Care was always taken to have the connections slope upward from the hydrant to the air-cocks so that when the cock was opened the swiftly flowing current of water washed out all air in the connections.

These gages gave directly the gross loss of pressure between the two points with which connection was made, this loss being the difference in height between the two columns less a slight correction for a column of water of a height equal to this difference. A measuring stick graduated directly in pounds and tenths of a pound was fitted between the legs of the tube and gave the readings directly in pounds.

---

*Condensed from the Journal of the New England Water-Works Association, being somewhat abridged from a paper presented before the Am. Soc. M. E. in 1899.

†"Experiments Relating to Hydraulics of Fire Streams." Transactions, American Society of Civil Engineers, Vol. XXI, Table B - No. 3.

Open-butt Tests.—In the open butt tests the water was discharged directly from the 2½-in. hydrant butt The floor of the test-room was of brick laid in cement with a large drain all prepared especially for this work, so that the water could be blown out anywhere in the room.

For the tests to and including No. 368 the mercury gage was connected to the 6 in. piezometer at the inlet of the hydrant, and a U-gage connected between this point and the connection on the back of the hydrant. The pressure at the outlets was then the mercury column reading corrected for elevation less the friction loss through the hydrant, which was given by the U-gage. After test No. 368 the mercury column was connected directly to the nipple at the back of the hydrant barrel opposite the outlets. This give the pressure directly at the outlets and was better than the first arrangement, as it avoided the errors of the U-gage.

Table I—Hydrant Friction Losses, One Stream Flowing.

Name of Hydrant	Friction Loss in Pounds with Various Rates of Flow. Gallons per Minute Flowing. 100			200			300			400			500		
	Barrel.	Nozzle.	Total.	Barrel.	Nozzle.	Total.	Barrel.	Nozzle	Total	Barrel	Nozzle.	Total	Barrel.	Nozzle	Total
	Lbs.	Lbs.	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs
B'um't L. H. outlet	0.07	0.25	**0.32**	0.23	0.76	**0.99**	0.49	1 49	**1.98**	0.85	2.68	**3.53**	1.36	4.89	**6.25**
B'um't R. H. "	0.07	0.18	**0.25**	0.23	0.59	**0.82**	0.49	1.24	**1.73**	0.85	2.24	**3.09**	1.36	3.99	**5.35**
Chapman No 1 .	0.01	0 19	**0.20**	0.07	0.69	**0.76**	0.17	1.47	**1.64**	0.32	2.74	**3.06**	0.51	4.98	**5.49**
" No. 2	0.03	0.05	**0.08**	0.08	0.26	**0.34**	0.16	0 58	**0.74**	0.27	1.11	**1.38**	0.40	2 05	**2.45**
" No. 3	0.02	0.01	**0.03**	0.07	0.15	**0.22**	0.14	0.41	**0.55**	0.22	0.87	**1.09**	0.34	1.55	**1.89**
Chapman 3 way....	0.03	0.32	**0.35**	0.12	0.84	**0.96**	0.27	1.61	**1.88**	0.47	2.80	**3.27**	0.73	4.87	**5.60**
" 4 way .	0.01	0.24	**0.25**	0.04	0.82	**0.86**	0.10	1.72	**1.82**	0 17	3.03	**3.20**	0 25		.....
Coffin Gate.	0.06	0 08	**0 14**	0.22	0.31	**0.53**	0.48	0.72	**1 20**	0.86	1.37	**2.23**	1.44	2.48	**3 92**
" Compression.	0.05	0.05	**0.10**	0.15	0.23	**0.88**	0.30	0.55	**0.85**	0.53	1.07	**1.60**	0.88	1.95	**2.83**
Corey 4-in.	0.07	0.04	**0.24**	0 23	0.19	**0.42**	0.49	0.44	**0.93**	0 85	0.93	**1.78**	1.37	1.76	**3,13**
" 5-"	0.01	0.03	**0 04**	0.07	0.18	**0.25**	0.17	0 41	**0.58**	0.32	0.73	**1.05**	0.51	1.21	**1.72**
Glamorgan, No. 1..	0.05	0.10	**0 15**	0.11	0.39	**0.50**	0.19	0.87	**1.06**	0.31	1 63	**1.94**	0.49	2.83	**8 32**
" No. 2..	0.02	0.37	**0.39**	0.07	1.29	**1.36**	0.14	2.73	**2.87**	0.22	4.88	**5.10**	0.34	8.28	**8.62**
Holyoke Gate, 4-in.	0.10	0.03	**0.13**	0.35	0.14	**0.49**	0.77	0.38	**1.15**	1.36	0.81	**2.17**	2.10	1.57	**3.67**
Holyoke Gate, 5¼-in.	0.05	0.07	**0.12**	0.15	0.29	**0.44**	0.30	0.70	**1 00**	0.53	1.41	**1.94**	0.88	2 61	**3 49**
" " 6¼-"	0.03	0.07	**0 10**	0.12	0.28	**0.40**	0.26	0.60	**0.86**	0.49	1.10	**1.59**	0.82	1.79	**2.61**
" Comp. No. 1	0.05	0.08	**0.18**	0.15	0.33	**0.48**	0.32	0.79	**1.11**	0.59	1.53	**2.12**	1.01	2.74	**3.75**
" " No. 2.	0.07	0.24	**0.31**	0.26	0.33	**0.59**	0.56	0.72	**1.28**	1.03	1 32	**2 35**	1.68	2.42	**4.10**
Hol'ke Gate, 4-way.	0.01	0.19	**0.20**	0.06	0.64	**0.70**	0.13	1.37	**1.50**	0.22	2.48	**2.70**	0.34	..	....
" " 6-way	....	...	**0.21**	....	...	**0.62**	....	....	**1.23**	..	..	**2.08**	.	....	**3 85**
Ludlow	0.04	0.10	**0:14**	0 13	0.40	**0.53**	0.26	0.94	**1.20**	0.45	1.78	**2 23**	0.71	3.21	**3.92**
Mathews 5 in.	0.07	0.09	**0.16**	0.25	0.34	**0.59**	0.54	0.76	**1.30**	0 97	1.46	**2.43**	1 56	2.69	**4.25**
Mathews 4-way..	0.03	0.29	**0.32**	0.09	1 09	**1.18**	0.18	2.22	**2 40**	0 31	3 99	**4.30**	0.47		
Pratt & Cady.......	0.02	0.12	**0.14**	0.07	0.39	**0.46**	0.14	0.87	**1.01**	0 23	1.68	**1.91**	0.34	2.92	**3.26**

Table II—Hydrant Friction Losses, Two Streams Flowing.

Name of Hydrant	Friction Loss in Pounds with Various Rates of Flow. Gallons per Minute Flowing. 300			400			500			600			700			800		
	Barrel.	Nozzle	Total	Barrel.	Nozzle	Total.	Barrel	Nozzle.	Total	Barrel	Nozzle.	Total	Barrel.	Nozzle	Total	Barrel.	Nozzle	Total.
	Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs	Lbs.
B'um't L. H. outlet	....	....	.....	....	....	.....	....	....	.....	....	....	.....	....	....	.....	....	....	.....
B'um't R. H. "	0.45	0.28	**0.73**	0.82	0.48	**1.30**	1.32	0.70	**2.02**	1.87	1.04	**2.91**	2.57	1.44	**4.01**	3.41	1.94	**5.36**
Chapman No 1 .	0.08	0.74	**0.82**	0.17	1.32	**1.49**	0.30	1.97	**2.28**	0.44	2.79	**3.2**[illegible]	0.61	3.86	**4.47**	0.78	5.24	**6 02**
" No. 2	0.12	0.36	**0.48**	0.19	0.58	**0.77**	0.30	0 88	**1.18**	0.44	0.30	**1.74**	0.61	1.79	**2.40**	0.80	2.30	**3.10**
" No. 3	0.13	0.19	**0.32**	0 20	0.33	**0.53**	0.31	0.51	**0.82**	0.46	0.75	**1.21**	0.63	1.04	**1.67**	0.82	1.36	**2.18**
Chapman 3 way....	0.20	0.55	**0.75**	0.38	0.91	**1.29**	0.62	1.33	**1.95**	0.92	1.86	**2.78**	1.30	2.75	**4.05**	1.75	4.24	**5.99**
" 4 way .	0.10	0 48	**0 58**	0.17	0.84	**1.01**	0.25	1.33	**1.58**	0.36	1.95	**2.31**	0.49	2.69	**3.18**	0.64	....	.....
Coffin Gate.	0.50	0.25	**0.75**	0.82	0.54	**1.36**	1.26	0.86	**2.12**	1.82	1.20	**3.02**	2.48	1.61	**4.00**	3.23	2.25	**5.48**
" Compression.	0.28	0.35	**0.63**	0.55	0.53	**1.08**	0.67	0.78	**1.65**	1.26	1.14	**2.40**	1.71	1.63	**3.34**	2.30	2.29	**4.59**
Corey 4-in.	0.42	0.23	**0.65**	0.75	0.32	**1.07**	1.16	0.47	**1.63**	1.62	0.73	**2.35**	2.18	1.06	**3.24**	2.78	1.49	**4.27**
" 5-"	0.14	0.12	**0.26**	0.27	0.22	**0.49**	0.43	0.35	**0.78**	0.62	0.54	**1.16**	0.86	0.78	**1 64**	1.11	1.08	**2.19**
Glamorgan, No. 1..	0.17	0 42	**0.59**	0.26	0.67	**0.93**	0.37	1.07	**1.44**	0.51	1.60	**2.11**	0 69	2 26	**2 95**	0 92	3.01	**3.98**
" No. 2..	0.14	0.78	**0.92**	0.21	1.41	**1.62**	0.33	2.17	**2.50**	0.48	3.07	**3.55**	0.69	4.15	**4.84**	0.93	5.54	**6.47**
Holyoke Gate, 4-in.	0.72	0.20	**0.92**	1.24	0.38	**1.62**	1.94	0.56	**2.50**	2.81	0.74	**3.55**	3.87	0 97	**4.84**	5.10	1.37	**6.47**
Holyoke Gate, 5¼-in.	0.25	0 35	**0.60**	0.48	0.54	**1.02**	0.79	0.78	**1.57**	1.15	1.12	**2.27**	1.57	1.60	**3 17**	2.08	2.29	**4.37**
" " 6¼-"	0.25	0.17	**0.42**	0 47	0.30	**0 77**	0.74	0.48	**1.22**	1.09	0.68	**1.77**	1.48	1.00	**2.48**	..	....	**3.36**
" Comp. No. 1	0.31	0.32	**0.63**	0.58	0.50	**1.08**	0.92	0.73	**1.65**	1.30	1.10	**2.40**	1.80	1.54	**3.34**	2.44	2.15	**4.59**
" " No. 2.	....	....	.....	....	....	.....	....	.	.....	....	.	.....	....	....	.....	....	....	.....
Hol'ke Gate, 4-way.	0.13	0.35	**0.48**	0.22	0.65	**0.87**	0.34	1.03	**1.37**	0.49	1.51	**2.00**	0.67	2.08	**2 75**	0.88	.	.....
" " 6-way	0 05	0 26	**0 31**	0.08	0.47	**0.55**	0.12	0.73	**0.85**	0.16	1.05	**1.21**	0.21	1.45	**1.66**	0.26	1.97	**2.23**
Ludlow	0.22	0.34	**0.56**	0.41	0.51	**0 92**	0.67	0.75	**1.42**	0.98	1.08	**2 06**	1.34	1.57	**2.91**	1.74	2.26	**4 00**
Mathews 5 in.	0.57	0.18	**0.75**	0 95	0.41	**1.36**	1.47	0.65	**2.12**	2.12	0.90	**3.02**	2.92	1.17	**4.09**	3.83	1.65	**5.48**
Mathews 4-way..	0.18	0.51	**0.69**	0.31	0.96	**1.27**	0.47	1.55	**2.02**	0.68	2.27	**2 95**	0.91	3.09	**4.00**	1.19	....	.....
Pratt & Cady.......	0.11	0.31	**0.42**	0.19	0.58	**0.77**	0 29	0.93	**1.22**	0.43	1.34	**1.77**	0.59	1.89	**2.48**	0.77	2.59	**3.36**

Friction Losses.—In all the tests observers were placed at the different gages and took readings simultaneously at the sound of a bell, a warning bell being struck five seconds before the time for the reading. The majority of the tests were of ten minutes' duration, and readings were taken each minute. A few of the tests were of five minutes' duration, and in these half-minute readings were taken.

In all cases after the water was started ample time was allowed before the readings were commenced, to make sure the water had come to a steady condition of flow.

The following program was adopted for all the friction-loss tests:

Condition.	Size of Meter Nozzle. Inches.	Approx Pressure at Nozzle. Lbs.	Approx Gallons per Min. Flow'g.
One hose outlet	¾	66	130
One hose outlet ...	1⅛	46	250
One hose outlet. .	1¼	33	350
One hose outlet.....	1¾	24	450
One hose outlet. .	2	19	550
Two hose outlets .	1¼	65	375
Two hose outlets....	1¾	30	500
Two hose outlets....	1¾	45	625
Two hose outlets	2	31	750
Two hose outlets....	2½	17	850

Before or after each series of tests the zero reading of the mercury column was obtained by filling gage connections with water and holding end level with center of the nozzle and then reading the gage.

At the end of a series of tests the averages were quickly computed and checked, and the gross loss in pounds and the gallons per minute discharged for each condition were plotted on cross-section paper and a curve drawn through the points. This gave a constant check on the work and quickly showed up any error. The occasional prompt finding of a discrepancy tended strongly to impress the observers with the need of care in taking readings and handling the apparatus. For this reason, and for the greater ease with which any trouble is located and remedied, and for the chance of studying the results and investigating at once while the apparatus is in place any special feature, this method of carrying the computations along with the work is believed of the greatest benefit to the experimenter. The chance of false readings was carefully guarded against by liberal blowing off of all connections before each test. For a number of hydrants series of tests were repeated to try the accuracy of the work, and it was almost invariably found that the two series agreed well within practical limits.

The question was raised whether the high velocity of water through the 2½-in. hydrant butt might not cause such a contraction of the stream as to affect the readings of the U-tube. Two series of tests were therefore made on one hydrant, one with the 2½-in. piezometer next to the hydrant outlet, which was the usual arrangement, and the other with a piece of 2½-in. pipe about 2 ft. long between the hydrant and the piezometer. A special test for the friction loss in this 2½-in. pipe was then made, and, correcting for this loss, the results were found to be practically the same in the one case as the other, showing that the piezometer screwed directly to the hydrant could be relied upon for accurate results.

Computations.—The average readings from each test have been copied on data sheets arranged with parallel columns. The main steps of the computations have also been put upon these sheets, thus giving a complete record of the work. The friction loss tests are arranged in alphabetical order according to the names of the hydrants, with all the tests on one make of hydrant grouped. The open-butt tests are in order of test numbers. For a few of the hydrants complete tests were not made for lack of time. The absence of data will show where these omissions occur.

The detailed tables of experimental results are not included with this paper since the Tables I to V inclusive, and the diagrams, show "the results in brief." For further details reference may be made to Transactions, American Society of Mechanical Engineers, Vol. XX, where the tables are given in full.

Open-Butt Tests.—The general method of procedure was the same as for the friction tests. The mercury column and the U-gage, in the tests where it was used, were read in the same way and with the same care as in the friction-loss tests. The quantity of water was obtained from the meters, the Worthington meter being used in all of the earlier tests, the Neptune meter in the later ones. The exact time in which the meter registered an even number of cubic feet was noted with a stop watch. To get an even number of cubic feet a definite number of revolutions of one of the dial hands was timed. This method is free from possible inaccuracies in the graduations of the meter registers.

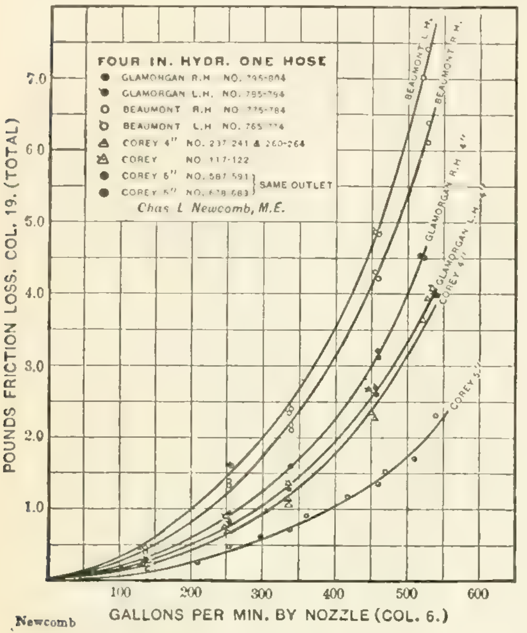


Fig. 1.

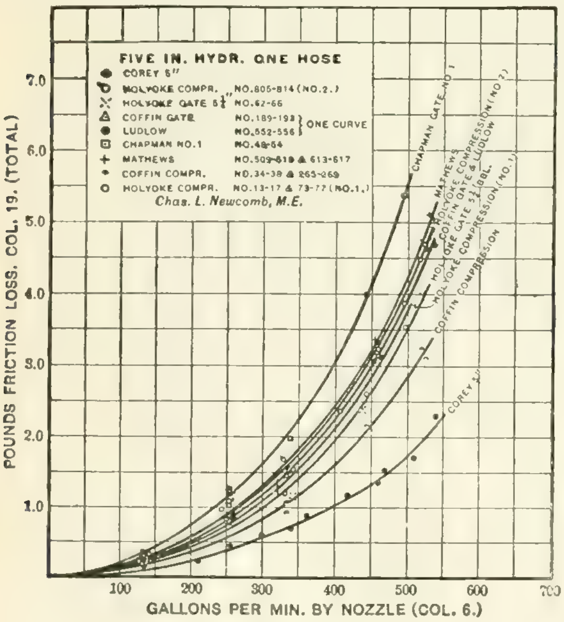


Fig. 2.

The average readings from each test and the main steps of the computations have been placed on data sheets similar to those used in the friction-loss tests.

On several hydrants tests were run first with the pressure taken at the usual connection at the back of the barrel, and second with the pressures taken at a connection tapped into a cap screwed to the other outlet of a two-way hydrant, and to any one of the other outlets if the hydrant had more than two outlets. The plotted points from the two tests gave practically the same curve, showing that where more convenient there is no objection to using a tapped hydrant cap.

Curves.—In addition to the rough plottings which, as already stated, were made as the work progressed, final curves were drawn from the completed results. It was from these curves, which give the best means of averaging the several experiments on any one hydrant, that the data for the tables designed for practical use were taken.

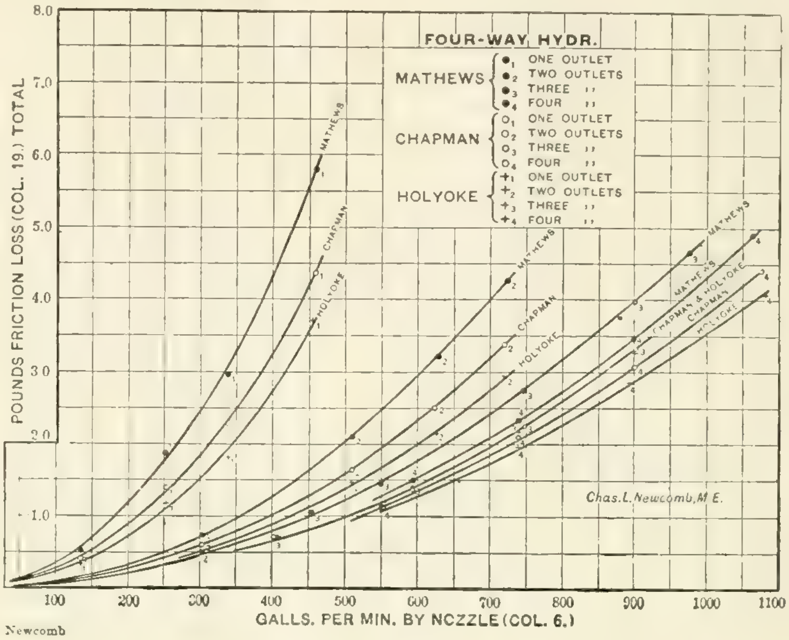


Fig. 3.

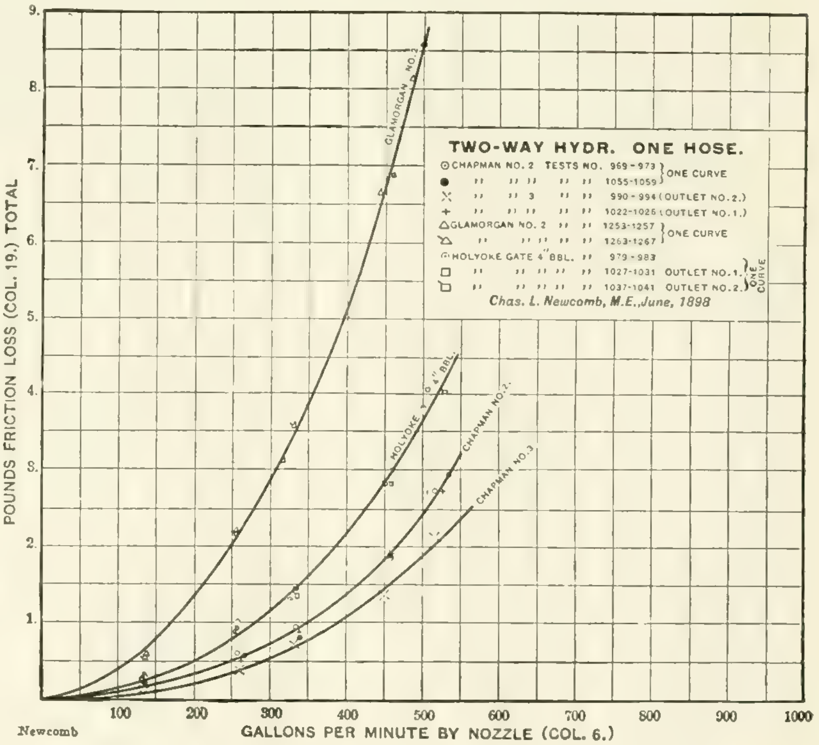


Fig. 4.

Figs. 1 to 4 inclusive are sample diagrams showing friction losses, giving actual friction losses for one co-ordinate and gallons per minute flowing for the other.

Fig. 5 gives a similar plotting for the open-butt tests, pressures at the back of the hydrant being taken for one co-ordinate, and gallons per minute for the other.

These curves give convenient means of studying the general uniformity of results and for interpolating between the points given in the summary tables. They also furnish a complete graphical record of the results which are shown in tabulated form on the data sheets. As many curves as were consistent with clearness have been plotted on one sheet, .and in general hydrants of similar main dimensions will be found plotted together.

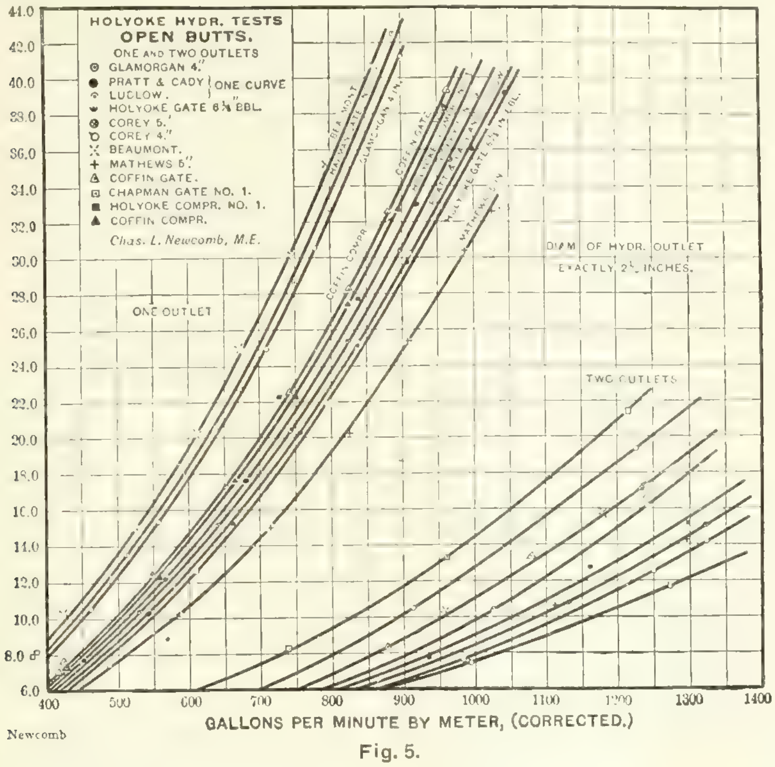


Fig. 5.

Accuracy—In the friction-loss tests the nozzle pressures were read to the nearest 0.1 lb., which represented a little less than one-quarter inch on the scale, and was, therefore, a very easily read division. The fluctuations under ordinary conditions, due to changes of pressure in the city mains, were less than one pound. When more than this, the unusual readings and the corresponding ones on the other gages were thrown out. It may safely be assumed that the nozzle pressures were correct within one-quarter of a pound. At the pressures worked at, this would mean an error in quantity of less than 1 per cent.

The U-gages in the later tests were read to the nearest 0.01 lb.; in the earlier ones to the nearest 0.05 lb., except for the very small losses, where somewhat closer readings were made. At the small losses there was almost no vibration of the mercury columns, thus facilitating accurate readings. For the larger losses careful throttling of the cocks reduced the vibrations to a small range. By plotting these losses with the quantities corresponding, and locating an average curve through the points, the errors tend to neutralize each other, and it will be seen by studying the plates that the points do very readily locate such curves and that but few of them lie far outside the average line. Losses read from these curves may be considered correct within 2 per cent.

In the open-butt tests the mercury column was read to the nearest 0.1 lb. The average pressure from the ten readings would probably not be in error more than 0.2 lb. and in general not more than 0.1 lb. In the tests where the mercury column was connected to the 6-in. piezometer the U-gage error also enters, but in general this did not exceed about 0.1 lb. This means, when using the U-tube, a maximum error of 0.3 lb., and without the tube, 0.2 lb. The percentage errors decrease with the increase of pressures.

In estimating on the meter just when the dial hand with the meter in motion passes the zero point, an error of 1½ cubic feet might be made. If the errors at the beginning and end happen to be the opposite direction, the maximum error would be 3 cu. ft. One hundred cubic feet was the smallest quantity passed in any test, and generally the quantity was considerably larger. Therefore in the worst case the percentage error in reading the meter does not exceed 3 per cent. The meters were calibrated by the nozzles, and an average curve plotted with meter readings for one co-ordinate, and nozzle quantities for the other. The errors in the meters were found to be practically constant for any given quantity, so that an error of over 1 per cent in the calibration is improbable.

The stop-watch was read to the nearest one-fifth second and was frequently rated so that with ordinary care the time should be correct within 1 per cent, and often closer. With the above errors happening to be all in one direction the determination of the discharge per minute in any one test might be 5 per cent out. This would be the worst condition, and in general the error would be much less.

In this work, as in the friction-loss tests, the results were plotted and average curves drawn. The results from these curves may reasonably be expected to be correct within 3 per cent.

The following hydrants were tested: Beaumont, 4⅛-in. gate opening; Chapman, Nos. 1, 2 and 3, having gates respectfully 4⅝ ins., 5 ins., and 7¾ ins.; Chapman Four Way, with 6 1/16-in. gate; Coffin Gate, with 4¾-in. gate; Coffin Compression, with 5-in. gate; Corey, 4 and 5 in.; Glamergan No. 1 and No. 2, with 4¼-in. and 6⅝-in. gates respectively; Holyoke Gate, 4 ins., 5 ins. and 6 ins.; Holyoke Compression Nos. 1 and 2, with 5½-in. and 4½-in. gates; Holyoke Four-Way, with 6-in. gate; Holyoke Six-Way, with 8-in. gate; Ludlow, with 5-in. gate; Matthews, 5-in.; Matthews Four-Way, 6⅜-in.; and Pratt and Cady, 6¼-in.

To put the results into shape for ready use the accompanying tables have been prepared: Tables I, II and III give the entire results of the friction-loss tests; Tables IV and V, the discharging capacity of open butts for the range of pressures covered by the tests. These tables were filled out by readings directly from the curves.

The open-butt tables are of value in test-

TABLE III. HYDRANT FRICTION LOSSES, THREE TO SIX STREAMS FLOWING.

Name of Hydrant and Gallons per Minute Flowing.	No. of Streams Flowing.	Friction Loss in Pounds with Various Rates of Flow.														
		Barrel.	Nozzle	Total.	Barrel.	Nozzle.	Total.	Barrel.	Nozzle.	Total.	Barrel.	Nozzle.	Total.	Barrel.	Nozzle.	Total.
Gallons per Min.		500			600			700			800			900		
Chapman 3-way .	3	0.60	0.70	**1.30**	0.87	1.01	**1.88**	1.18	1.42	**2.60**	1.56	1.89	**3.45**	2.00	2.40	**4.40**
" 4-way .	3	0.25	0.70	**0.95**	0.36	1.05	**1.41**	0.49	1.46	**1.95**	0.64	1.96	**2.60**	0.80	2.51	**3.31**
Holyoke 4-way ..	3	0.35	0.60	**0.95**	0.49	0.92	**1.41**	0.67	1.28	**1.95**	0.88	1.72	**2.60**	1.11	2.20	**3.31**
" 6-way ..	3	0.12	0.35	**0.47**	0.16	0.50	**0.66**	0.21	0.69	**0.90**	0.26	0.92	**1.18**	0.32	1.21	**1.53**
Mathews 4-way .	3	0.47	0.73	**1.20**	0.68	1.07	**1.75**	0.91	1.49	**2.40**	1.19	1.97	**3.16**	1.49	2.51	**4.00**
Gallons per Min.		600			700			800			900			1,000		
Chapman 4-way .	4	0.36	0.97	**1.33**	0.49	1.34	**1.83**	0.64	1.76	**2.40**	0.80	2.25	**3.05**	0.96	2.84	**3.80**
Holyoke 4-way .	4	0.49	0.76	**1.25**	0.67	1.04	**1.71**	0.88	1.38	**2.26**	1.11	1.75	**2.86**	1.35	2.20	**3.55**
" 6-way ..	4	0.16	0.50	**0.66**	0.21	0.69	**0.90**	0.26	0.92	**1.18**	0.32	1.21	**1.53**	0.38	1.57	**1.95**
Mathews 4-way ..	4	0.68	0.84	**1.52**	0.91	1.16	**2.07**	1.19	1.53	**2.72**	1.49	2.04	**3.45**	1.81	....	**4.32**
Gallons per Min.		1,100			1,200			1,300			1,400			1,500		
Holyoke 6-way . .	5	0.46	0.98	**1.44**	0.54	1.21	**1.75**	0.63	1.47	**2.10**	0.75	....	....	0.91	....	....
" 6-way ..	6	0.46	0.61	**1.07**	0.54	0.71	**1.25**	0.63	0.85	**1.48**	0.75	1.00	**1.75**	0.91	1.14	**2.05**

ing water works systems to determine their capacities at useful pressures where either lack of time or facilities prevents using more accurate apparatus. In such cases the open butt gives, quickly and inexpensively, fairly accurate results for this kind of work. Differences in design and construction of the outlet materially affect the discharge, but a study of the tables, together with the cuts of the hydrants, will enable one to apply intelligent corrections for outlets differing from any here tested.

In practice the gage would often be connected into a tapped hole in a hydrant cap and the cap screwed to one of the other outlets of the hydrant if it had more than one. This in all ordinary cases would give the same result as a connection tapped into the back of the hydrant, as was the case in most of the tests. The few tests in which the gage was connected first one way and then the other show practically no difference in the result.

The data and results being presented in full give ample chances for complete studies. Under these conditions detailed comparisons of the different hydrants have not been considered necessary or wholly desirable. A few general features may, however, be considered to advantage.

Barrel Loss.—The best point of comparison for the two-way hydrants is with two hose outlets in use and 500 gallons per minute flowing, as this represents the full normal capacity of the hydrant. Similar full-capacity points should be taken in comparing the larger hydrants.

To make clear the composition of the so-called barrel loss, the following table has been made and shows about how much of this loss occurs in the barrels proper. The figures show at once that a large part of the loss must be in the gate and the sharp turn just beyond it, thus suggesting where to look for explanation for part of the large difference found. The distance from the center of the main gate to the center of the nozzles is, on the average hydrant, about 6½ ft. The following table gives approximately the friction loss of 6½ ft. of clean, straight cylindrical pipe of the same smoothness as the inside of the average hydrant barrel:

Nominal Diameter of Pipe (Inches)	FRICTION LOSS IN 6½ FEET. POUNDS PER SQUARE INCH. Gallons per Minute Flowing.			
	250.	500.	750.	1,000.
4	0.11	0.41	0.62	1.54
5	0 037	0.13	0.22	0 50
6	0.012	0 059	0 098	0.21
8	0.004	0.016	0 034	0 058

The table was made up from tests on ordinary new clean wrought-iron pipe with 25 per cent added to the wrought-iron pipe figures for the somewhat greater roughness of the inside of the average hydrant casting. The 25 per cent was an assumption based on general experience with pipes of various degrees of roughness.

A comparison of the test of hydrants having 2½-in. outlets shows the difference in the barrel losses to be large.

It is at once apparent that the 4-in. gate and barrel are too small for a two-stream hydrant. A 4-in. barrel and a discharge of 500 gallons per minute mean a velocity of about 13 ft. per second, so that a short length of barrel with the smoothest sort of a turn at the bottom develops an unreasonable loss, and this loss becomes still larger with the ordinary gate arrangement and sharp turn-bend.

Comparing further the hydrants which have about the same general dimensions, the difference in loss is considerable. This must be accounted for largely by differences in the design of the gate and the water passages in the immediate vicinity. Sharp corners, restricted sections, and sudden changes in the area of the passages all tend to produce eddyings, which use up pressure.

TABLE IV.—DISCHARGE OF ONE OPEN HYDRANT BUTT.

NAME OF HYDRANT.	DISCHARGE THROUGH ONE OPEN BUTT OR HYDRANT WITHOUT HOSE ATTACHED. (DIAMETER OF OUTLET EXACTLY 2½ INCHES.) GALLONS PER MINUTE. Hydrant Pressure indicated while Stream is Flowing, by Gauge attached to Hydrant as shown.* Pounds per Square Inch.								
	10	15	20	25	30	35	40	45	50
Beaumont	426	526	608	678	743	799	852	...	..
Chapman No. 1..	440	541	627	700	762	818	872	. .	..
" No. 2..	547	667	765	853	938	1,020	1,098	.	.
" No. 3..	552	668	776	861	928	986	1,034	1,077	..
Chapman 3-way.	371	458	531	593	648	701	742	792	834
" 4-way.	363	444	513	573	630	680	725	767	806
Coffin Gate . . .	497	607	701	780	850	913	974	.....	...
" Compression	501	612	709	790	860	924	985	.....	.
Corey 5-in	520	640	737	820	893	962	1,025	...	
Glamorgan 4-in..	449	550	636	709	773	831	986	..	
Hol.Gate,4-in.bbl	500	612	703	783	857	927	994	1,058	
" " 6½ in.bbl	545	663	760	844	921	992	1,048	.....	..
Hol. Comp. No. 1	512	628	723	804	876	942	1,003	....	.
" Gate, 6-way	473	579	668	743	805	860	908	954	997
Ludlow..........	533	653	752	836	912	982	1,049	. .	
Mathews 5-in....	576	712	815	903	984	.	.....	.....	..
Mathews 4-way..	465	565	633	683	725	762	796	827	857
Pratt & Cady....	633	653	752	836	912	982	1,049	...	.

*Pressure can be equally well measured by tap at back of barrel opposite outlets.

Nozzle Loss.—As already stated, the nozzle losses are pure friction losses, full correction for velocity having been made. To compare the outlets themselves, looking at them as simple nozzles, the condition with one stream on and 250 gallons per minute flowing is the best point. Studying the losses and the cut together, the effect of sharp, jagged corners at the outlets is immediately seen, and the very material reduction in loss by even a slight rounding of the outlet is apparent.

Considering the hydrant as a whole, by taking the conditions, with all of the outlets in use, it is seen that the average nozzle loss when all are in use is generally greater than with a single outlet in use. Separate tests on the two outlets of several hydrants showed a difference in loss with the same quantity flowing. This would account for a small part of the difference between loss with one outlet in use and with all outlets in use. Most of the difference is, however, undoubtedly due to the increase in choking and eddying effects at the top of the hydrant with the higher velocities. A part of this is due to reactions from the eddies at the outlets and a part to the construction of the hydrant head.

The somewhat high losses with the Beaumont hydrant, considering the rounding outlets, is probably due to the fact that the gage connection was necessarily several inches below the outlet, so that there was considerable length between the gage connection and the outlet, in which length some ordinary friction loss would occur.

Total Losses.—It is desirable that the waste of pressure through a hydrant should be as small as it is practicable to make it. In high-pressure systems the losses found for the average hydrants are perhaps tolerable, but in lower-pressure systems—and many systems having a nominally high pressure become low under heavy drafts—every avoidable loss is objectionable. In the hydrants without independent gates a simple rounding of the corners of the core at the outlet will make a material improvement in the nozzle losses. Reduction of loss for independent gate hydrants is more difficult, but some improvement is probably possible without serious trouble. The fact that some makers have found out how to reduce the barrel losses, so called, to comparatively small amounts is good working ground for improvements in those hydrants now having rather large losses.

It is not to be understood that this friction loss is the criterion for a perfect hydrant. Certainty of action under all conditions is of the greatest importance, but, other things being equal, the hydrant having the smallest total friction loss when working at its full capacity is the best.

TABLE V.—DISCHARGE OF TWO AND THREE OPEN HYDRANT BUTTS.

NAME OF HYDRANT.	No. of Outlets Open.	DISCHARGE THROUGH OPEN BUTTS OF HYDRANT WITHOUT HOSE ATTACHED. (DIAMETER OF OUTLET EXACTLY 2½ IN.) GALLONS PER MINUTE. Hydrant Pressure indicated while Stream is Flowing, by Gauge attached to Hydrant Barrel as shown.* Pounds per Sq. In.				
		5	10	15	20	25
Beaumont	2	..	904	1,158	1,327	.
Chapman No. 1.....	2		827	1,020	1,173	.
" No. 2....	2	.	974	1,197	1,377	....
" No. 3....	2		997	1,252	1,448	......
Chapman 3 way.. .	2	.	876	1,074	1,223	1,329
" 4-way.. ..	2	..	868	1,063	1,212	... .
Coffin Gate	2	.	904	1,158	1,327	...
Corey 4-in.........	2		1,170	.	......	......
Corey 5-in...........	2	.	1,091	1,322	..	..
Glamorgan 4-in.....	2	..	894	1,082	1,248	.
Hol'ke Gate,4-in.bbl	2		985	1,202	......	.....
" " 6½-in.bbl	2	.	1,125	1,368	......	
Holyoke Comp. No.1	2		1,051	1 278	......	...
" Gate, 6-way	2	.	942	1,152	1,326	1,466
Ludlow	2	.	1,008	1,200	1,364	......
Mathews 5-in.........	2	...	1,091	1,322	......	......
Mathew 4-way......	2	..	890	1,089	1,238	1,341
Holyoke Gate, 6.way	3	992	1,388	. .	......	
Mathews 4-way.....	3	940	1,304	1,596	......	.....

*Pressure can be equally well measured by tap at back of barrel opposite outlets.

CONTRACT NEWS

INDEX.

	PAGES
Bids Asked	19
Bridges	20
Buildings	20
Roads and Streets	20
Sewers	21
Water Supply	21
Excavation	21
Miscellaneous	22
Material, Machines, etc	22
Contracts Let	22

We shall welcome any news notes that our readers may send in. Notes of contracts awarded, bidding prices, etc., will be especially acceptable.

BIDS ASKED

Bridges.

Bids Open.		See Issue.
June 24.	Sacramento, Cal.	June 17
June 24.	Goshen, Ind.	June 3
June 25.	Muskegon, Mich.	June 10
June 25.	Dayton, O.	June 17
June 25.	Kansas City, Mo.	June 17
June 26.	Mitchell, S. Dak.	June 10
June 26.	Cincinnati, O.	June 10
June 27.	Findlay, O.	June 10
June 29.	Zanesville, O.	June 10
June 30.	West Allis, Wis.	June 17
June 30.	Norfolk, Va.	June 17
July 1.	Cleveland, O.	June 10
July 1.	Somerset, Pa.	June 24
July 1.	South Bend, Ind.	June 24
July 3.	Easton, Pa.	June 24
July 3.	Cincinnati, O.	June 17
July 6.	Max Meadows, Va.	June 24
July 6.	Greenwood, Miss.	June 24
July 6.	Rochester, Ind.	June 24
July 6.	La Porte, Ind.	June 24
July 7.	Jasper, Ind.	June 24
July 7.	Oregon, Mo.	June 24
July 7.	Vincennes, Ind.	June 17
July 7.	Yreka, Cal.	June 3
July 8.	Eureka, Cal.	June 10
July 8.	Dayton, O.	June 17
July 8.	Coshocton, O.	June 17
July 8.	Rochester, Ind.	June 24
July 10.	Connersville, Ind.	June 17
July 14.	Lander, Wyo.	June 17
July 14.	Fargo, N. Dak.	June 17
July 14.	Lewiston, Idaho	June 24
June 26.	Buffalo, N. Y.	June 24
June 27.	Greencastle, Ind.	June 24
June 29.	Allentown, Pa.	June 24
June 30.	Rapid City, S. Dak.	June 24
July 6.	Milwaukee, Wis.	June 24
July 10.	Lorain, O.	June 24
July 20.	Fredericton, N. B.	June 17
July 18.	Dayton, O.	June 24

Buildings.

June 24.	Pittsburg, Pa.	June 17
June 24.	Albany, N. Y.	June 10
June 24.	Fayetteville, Ark.	May 20
June 24.	Jefferson Barracks, Mo.	June 3
June 24.	Riverside, Cal.	June 3
June 25.	Sandy Hook Proving Ground, N. J.	June 3
June 25.	Greenville, Tex.	May 20
June 25.	Auburn, N. Y.	June 10
June 25.	Beatrice, Neb.	June 27
June 25.	Wilkesbarre, Pa.	June 24
June 26.	Fort Totten, N. Y.	June 17
June 26.	Albany, N. Y.	June 17
June 27.	Canandaigua, N. Y.	June 10
June 27.	Crafton, Pa.	June 24
June 29.	New York, N. Y.	June 24
June 29.	New York, N. Y.	June 24
June 29.	Brooklyn, N. Y.	June 24
June 29.	Massillon, O.	June 10
June 29.	Fort D. A. Russell, Wyo.	June 10
June 29.	Sumter, S. C.	May 27
June 29.	Sioux City, Ia.	June 3
June 29.	Sioux City, Ia.	June 17
June 29.	Mont Alto, Pa.	June 17
June 30.	Meadville, Pa.	May 20
June 30.	Chicago, Ill.	June 24
July 1.	Cayuga, N. Dak.	June 24
July 1.	Baltimore, Md.	May 27
July 1.	Memphis, Tenn.	June 10
July 1.	Phoenix, Pa.	June 17
July 2.	Columbia, Tenn.	May 27
July 2.	Washington, D. C.	June 10
July 2.	Crown Point, Ind.	June 24
July 3.	West Point, N. Y.	June 10
July 6.	Marietta, Ga.	May 27
July 6.	Canton, O.	June 24
July 7.	Iola, Kan.	June 3
July 7.	Douglasville, Ga.	June 10
July 7	Spring City, Pa.	June 17
July 7.	Newark, N. Y.	June 17
July 8.	Bremerton, Wash.	June 17
July 8.	Cheyenne, Wyo.	June 10
July 8	Norristown, Pa.	June 24
July 9.	Springfield, O.	June 10
July 10.	Rhinelander, Wis	June 24
July 14.	Sharon, Pa.	June 10
July 14.	Annapolis, Md.	June 24
July 15.	Valdosta, Ga.	June 10
July 15.	Des Moines, Ia	June 24
July 16.	Augusta, Me.	June 17
July 20.	Auburn, Me.	June 10
July 21.	Coldwater, Mich.	June 17
July 22.	Paris, Tenn.	June 17
July 23.	Alton, Ill.	June 17
July 24.	Belleville, Ill.	June 17
July 30.	Portland, Me.	June 24
Sept. 23.	Green Bay, Wis.	June 17

Roads and Streets.

June 24.	Lebanon, Pa.	June 3
June 24.	Cadiz, O.	June 3
June 24.	Madison Barracks, N. Y.	June 10
June 24.	Indianapolis, Ind.	June 10
June 24.	Brooklyn, N. Y.	June 17
June 24.	Hoboken, N. J.	June 17
June 24.	Baltimore, Md.	June 17
June 24.	Chicago, Ill.	June 17
June 25.	Erie, Pa.	June 17
June 25.	Kansas City, Mo.	June 17
June 25.	Adams, Mass.	June 17
June 25.	Milwaukee, Wis.	June 24
June 25.	Lima, Oo.	June 24
June 26.	Pittsburg, Pa.	June 24
June 26.	Easton, Pa.	June 24
June 26.	Chicago, Ill.	June 17
June 26.	Cincinnati, O.	June 10
June 26.	Cincinnati, O.	June 10
June 27.	Omaha, Neb.	June 17
June 27.	New Lexington, O.	June 24
June 27.	South Newburgh, O.	June 24
June 29.	New York, N. Y.	June 24
June 29	North Milwaukee, Wis.	June 24
June 29	Chattanooga, Tenn.	June 24
June 29.	Spring City, Pa.	June 24
June 29.	Toledo, O.	June 24
June 29.	Vincent, Ia.	June 24
June 29.	Montgomery, Ala.	June 24
June 29.	Erie, Pa.	June 17
June 29.	Harrisburg, Pa.	June 3
June 30.	Harrisburg, Pa.	June 3
June 30.	Farmville, Va.	June 17
June 30.	Williamsport, Pa.	June 17
June 30.	Harrisburg, Pa.	June 17
June 30.	Ada, O.	June 17
June 30.	Wellsville, N. Y.	June 24
June 30.	Frankfort, Ind.	June 24
June 30.	Storm Lake, Ia.	June 24
June 30.	Washington, D. C.	June 24
July 1.	Columbus, O.	June 24
July 1.	Concord, Neb.	June 3
July 1.	Fort Barrancas, Fla.	May 27
July 2.	Bozeman, Mont.	June 10
July 2	Northport, N. Y.	June 24
July 2	New York, N. Y.	June 24
July 3.	Elizabeth, N. J.	June 24
July 3.	Cincinnati, O.	June 17
July 6.	Bentleyville, Pa.	June 17
July 6.	Tipton, Ind.	June 17
July 6.	Wilkesbarre, Pa.	June 24
July 6.	Indianapolis, Ind.	June 24
July 6.	Bentleyville, Pa.	June 24
July 6.	Salem, N. J.	June 24
July 6.	Camden, N. J.	June 24
July 6.	South St. Paul, Minn.	June 24
July 7	Rhinelander, Wis.	June 24
July 7.	Cape May C. H., N. J.	June 24
July 7.	Aurora, Ill.	June 24
July 7.	Rockville, Md.	June 24
July 7.	Rockville, Ind.	June 24
July 7.	Paoli, Ind.	June 24
July 7.	Cleveland Heights, O.	June 17
July 7.	Vincennes, Ind.	June 17
July 8.	Muncie, Ind.	June 17
July 8.	Peru, Ind.	June 24
July 10.	Rushville, Ind.	June 17
July 11.	Crawfordsville, Ind.	June 24
July 11.	Washington, D. C.	June 24
July 11.	Washington, D. C.	June 24
July 14.	Lander, Wyo.	June 17
July 15.	Cleveland, O.	June 10
June 30.	Columbus, Miss.	June 10
July 1.	Waterloo, N. Y.	June 10
July 1.	Elizabeth, N. J.	June 3
July 1.	Dillon, Mont.	June 17
July 1.	Owen, Wis.	June 24
July 1.	Paragould, Ark.	June 24
July 1.	Painesville, O.	June 24
July 2.	Winnebago, Minn.	June 24
July 6.	Hudson, Wis.	June 24
July 6.	Omaha, Neb.	June 24
July 6.	Eureka, Cal.	June 24
July 6.	Bentleyville, Pa.	June 17
July 6.	Corlett, O.	June 17
July 6.	Plainfield, N. J.	June 17
July 7.	Cleveland Heights, O.	June 17
July 7.	Newark, N. Y.	June 17
July 8.	David City, Neb.	June 24
July 10.	Andalusia, Ala.	June 17
July 18.	New Bremen, O.	June 24
July 23.	Cleveland, O.	June 24

Sewers.

June 24.	Louisville, Ky.	June 17
June 25.	Milwaukee, Wis.	June 24
June 25.	Newton, Kan.	June 10
June 26.	Pittsburg, Pa.	June 24
June 27.	Fort Adams, R. I.	June 24
June 27.	Fort Leavenworth, Kan	June 24
June 27.	Albuquerque, N. Mex.	June 17
June 29.	Washington, D. C.	June 17
June 29.	Merrill, Wis.	June 24
June 29.	Steubenville, O.	June 24
June 29.	Sturgeon Bay, Wis.	June 24
June 29.	North Milwaukee, Wis.	June 24
June 29.	Pittsburg, Pa.	June 24
June 29.	Jefferson City, Mo.	June 24
June 29	Iron River, Mich.	June 24
June 30.	Ashtabula, O.	June 24
June 30.	Virginia, Minn.	June 24
June 30.	Williamsport, Pa.	June 17
June 30.	Lexington, Ky.	June 17
June 30.	Rushville, Ind.	June 17

Water Supply.

	Grand Haven, Mich	June 24
June 26.	Brooklyn, N. Y.	June 17
June 26.	Chicago, Ill.	June 17
June 29.	Pittsburg, Pa.	June 10
June 29.	North Milwaukee, Wis.	June 24
June 30.	Towner, N. Dak.	June 24
June 30.	Norfolk, Neb.	June 24
June 30.	Columbia, Miss.	June 10
July 1.	Lewisburg, O.	June 3
July 1.	Elgin, Minn.	June 24
July 2.	Newton Falls, O.	June 24
July 6.	Batavia, Ill.	June 24
July 6.	Ricketts, Ia.	June 24
July 7.	Toledo, O.	June 10
July 7.	Cleveland Heights, O.	June 17
July 7.	Cherokee, Ia.	June 24
July 7.	Sturgeon Bay, Wis.	June 24
July 10.	Reading, Pa.	June 24

Miscellaneous.

June 24.	Columbus, O.,	Garbage Works, June 17
June 26.	Chapman, Ky.,	Dam, Walls, June 3
June 27.	Riverton, Ala.,	River Wall, June 3
June 29.	Fort Screven, Ga.,	Sea Wall, Etc., June 17
June 29.	Cobourg, Ont.,	Breakwaters, June 17
June 30.	Mont Alto, Pa.,	Garbage Plant, June 17
July 1.	Lewisburg, O.,	Electric System, June 3
July 1.	Boston, Mass.,	Street Lighting, June 10
July 2.	Saltpeter, W. Va.,	Dam, Guide Walls, Etc., June 10
July 2.	New York, N. Y.,	Concrete Wall, Etc., June 24
July 2.	Wilmington, Del.,	Retaining Wall, June 24
July 3.	Washington, D. C.,	Submarine Rock Drill Barge, June 17
July 6.	Boston, Mass.,	Piping, June 10
July 8.	St. Andrews, Man.,	Dam, Etc., May 27
July 10.	Wilmington, Del.,	Metal Work, June 24
July 14.	Chicago, Ill.,	Wrecking Building, June 3
July 14.	Lander, Wyo.,	Syphon, June 17
July 15.	North Chicago, Ill.,	Tunnel, Etc., June 17
July 15.	Toronto, Ont.,	Transmission Line, June 10
July 15.	Nashville, Tenn.,	Lock Gates, June 24
June 16.	Carrollton, Miss.,	Electric Plant, May 27
July 17.	Los Angeles, Cal.,	Aqueduct, May 27
July 18.	Bremerton, Wash.,	Dry Dock, June 17
July 23.	Wilkesbarre, Pa.,	Street Lighting, June 24
July 27.	Los Angeles, Cal.,	Aqueduct, June 17
Aug. 14.	Portland, Ore.,	Light House, May 27
Aug. 27.	Orland, Cal.,	Dam, Spillway,Dikes, June 24

Excavation, Earth and Rock.

June 24.	Brooklyn, N. Y.,	Grading Lots, June 17
June 25.	Seattle, Wash.,	Dredging, June 10
June 30.	Duluth, Minn.,	Dredging, June 17
June 30.	New York, N. Y.,	Dredging, June 17
July 1.	Crookston, Minn.,	Ditch, June 10
July 3.	Bremerton, Wash.,	Dredging, June 17
July 3.	Bledsoe, Ark.,	Levee Work, June 24
July 6.	Hastings, Minn.,	Ditch, June 17

July 7. Glenwood, Minn., Ditch Work, June 24
July 8. Vicksburg, Miss., Levee Work, June 17
July 8. Stockton, Cal., Diverting Canal, June 17
July 8. Sioux Falls, S. Dak., Ditch Work, June 24
July 9. Elk Point, S. Dak., Ditch Work, June 24
July 9. Danville, Pa., Filling, June 24
July 10. Connersville, Ind., Fill, June 17
July 17. New York, N. Y., Rock Removal, June 24
July 17. Detroit, Mich., Dredging, June 24
July 23. Syracuse, N. Y., Creek Improvement, June 24

Materials, Machines, Supplies, Tools, Etc.

June 24. Chicago, Ill., Electrical Apparatus, June 10
June 24. Washington, D. C., Boiler Room Equipment, June 3
June 24. Scranton, Pa., Fire Hose, June 17
June 25. Mont Alto, Pa., Laundry Equipment, June 17
June 25. Brooklyn, N. Y., Topsoil, June 17
June 25. Grand Rapids, Mich., Pumping Machinery, June 10
June 26. Brooklyn, N. Y., Stopcocks, June 17
June 26. Pittsburg, Pa., Water Meters, June 24
June 27. Washington, D. C., Corporation Cocks, June 10
June 30. New Orleans, La., Machinery, Apr 22
June 30. Williamsport, Pa.,
June 30. Williamsport, Pa., Dump Wagons, June 24
July 1. Baltimore, Md., Weedicide, June 24
July 1. Chicago, Ill., Steel Poles, Cross Arms, Etc., June 24
July 1. Pensacola, Fla., Pipe and Specials, June 24
July 1. Washington, D. C., Stokers, June 24
Street Signs, June 17
July 1. Ottawa, Ont., Machinery, June 17
July 1. Memphis, Tenn., Fire Alarm System, Clocks, Etc., June 10
July 2. Galveston, Tex., Pumping Equipment, June 17
July 2. Chicago, Ill., Fire Alarm Cable, June 24
July 3. White Plains, N. Y., Electrical Equipment, Etc., June 24
July 7. Houston, Tex., Pumping Engine, June 10
July 8. Atlanta, Ga., Boilers, June 3
July 8. Detroit, Mich., Electric Plant, June 24
July 10. Chicago, Ill., Vacuum Cleaning System, June 10
July 10. Madison, Wis., Heaters, Pumps, Etc., June 17
July 11. Philadelphia, Pa., Ash Handling Plant, June 17
July 16. Fort Dade, Fla., Ice Plant, June 24
July 29. New Boston, Ill., Pumping Plant, June 24

BIDS ASKED

Bridges.

Bids are asked on following work, the notes being arranged alphabetically by states:

Lewiston, Idaho.—Until July 14, by County Commissioners, W. L. Clifford, Clerk, for constructing bridge over Lawyers' Canyon.

Greencastle, Ind.—Until June 27, G. D. V. Moffett, County Auditor, for the construction of three bridges including both the substructure and superstructure.

Jasper, Ind.—Until 10:30 a. m., July 7, by M. A. Sweeney, County Auditor, for constructing a 30 ft., a 31 ft. and two 14 ft. long bridges.

La Porte, Ind.—Until July 6, by County Commissioners, according to reports, for constructing double span 282 ft. bridge with concrete abutments over the Kankakee River at Riverside.

Rochester, Ind.—Until 2 p. m., July 8, by Geo. W. DuBois, County Auditor, for construction of a steel and wrought iron bridge of 171 ft. span, 16 ft. roadway over the Tippecanoe River. Separate bids are asked for constructing two concrete abutments for the bridge.

Rochester, Ind.—Until 2 p. m., July 6, by Geo. W. DuBois, County Auditor, for constructing concrete arch over ditch in Wayne Township.

South Bend, Ind.—Until 11 a. m., July 1, by John W. Harbou, Couty Auditor, for construction of two steel I-beam bridges, one pony truss bridge, reconstructing one bridge and one new concrete abutment.

Greenwood, Miss.—Until July 6, by County Supervisors, C. W. Crockett, Clerk, for following work: Construction of bridge across Tippo; make hill 100 ft. on south side, to be 5 ft. higher than present bridge, using old lumber; 80-ft. bridge over Goose Pond slough; bench bridge over Swift bayou in Beat 5, about 150 ft. long; bench bridge in Beat 5 across bayou on McNutt road, about 100 ft. long; bench bridge over cave on the river bank, to be about 32 ft. long.

Oregon, Mo.—Until 8 p. m., July 7, by Wm. M. Morris, County Highway Engineer, for building two 18 ft. span bridges, three 22 ft. span, one 26 ft. span, two 36 ft. span and one 51 ft. span bridges.

Buffalo, N. Y.—Until 11 a. m., June 26, by Department Public Works, for substructure of bridge on River St. over Slip No. 1.

Dayton, O.—Until noon, July 18 (change of date from July 8), by Board Public Service, Wm. A. Budroe, Clerk, for construction of a concrete-steel bridge (Melan system), 685 ft. long, 40 ft. roadway, 9 ft. sidewalks, over Great Miami River at Stratford Ave. Fred J. Cellarius, City Civil Engineer.

Lorain, O.—Until 1 p. m., July 10, by County Commissioners, James L. Martin, County Auditor, for constructing concrete arch bridge of two spans, 75 ft. each, and 18 ft. roadway, in Falls Township. Alternate bids are asked on a steel superstructure 150 ft. long, 18 ft. roadway and concrete floor. Bids are also asked for abutments for the steel superstructure. James Bebout, County Surveyor.

Allentown, Pa.—Until June 29, by County Commissioners, for constructing reinforced concrete bridge over Mill Creek at New Smithville.

Easton, Pa.—Until July 3, by County Commissioners, L. A. Francisco, County Engineer, for repairing bridges.

Somerset, Pa.—Until July 1, by County Commissioners, for constructing a number of bridges.

Rapid City, S. Dak.—Until June 1, by Robt. Rudesill, County Auditor, for constructing two steel wagon bridges to span Rapid Creek about one mile above city.

Max Meadows, Va.—Until July 6, by County Supervisors, J. H. McGavoch, Chairman, Max Meadows, for constructing 150 ft. long iron bridge over Reed Creek.

Milwaukee, Wis.—Until July 6, by Board Public Works, C. J. Poetsch, Chairman, for erecting concrete steel arch viaduct over Milwaukee R. R. tracks at western end of Highland Ave. Viaduct is to be 446 ft. long and 75 ft. wide.

Buildings.

Bids are asked on following work, the notes being arranged alphabetically by states:

Des Moines, Ia.—Until July 15, at office of Hallett Rawson, Architects, 514 Utica Bldg., Des Moines, for erection of a school house in the Elm Grove District, Bloomfield Township.

Chicago, Ill.—Until noon, June 30, by Special Park Commission, A. W. O'Neill, Secretary, 118 City Hall, for construction of a shelter house, storage room, sand court, toilet rooms and office at the Municipal playground located on West Twenty-second St.

Crown Point, Ind.—Until July 2, by J. F. Meeker, for erection of new high school building.

Annapolis, Ind.—Until noon, July 14, by Building Committee, County School Commissioners, care Superintendent of County Schools, for erection of a public school building at Dorsey, Md.

Portland, Me.—Until 3 p. m., July 30, by James Knox Taylor, Supervising Architect, Washington, D. C., for construction complete (except elevator) of U. S. Court House at Portland.

Cayuga, N. Dak.—Until July 1, by Ed. Sturdevant, for erection of a church building.

Brooklyn, N. Y.—Until 11 a. m., June 29, by C. B. J. Snyder, Superintendent of School Buildings, Park Ave. and 59th St., New York, for installing electric equipment for new public school 93, security required $4,000, and for installing heating and ventilating apparatus in new public school 158, security required $20,000.

New York, N. Y.—Until 11 a. m., June 29, by C. B. J. Snyder, Superintendent of School Buildings, Park Ave. and 59th St., for following work: Repairs to heating and ventilating apparatus in 9 public schools, alterations, repairs, etc., for 16 public schools, repairs to heating and ventilating apparatus for 9 public schools, alterations and additions to electric equipment in 8 public schools, alterations, repairs, etc., to 8 public schools in Borough of Queens.

New York, N. Y.—Until 11 a. m., June 29, by John V. Coggey, Commissioner of Correction, 148 E. 20th St., for furnishing all the labor and materials required to install new metal ceilings in pavilion No. 1, new truss roof on old boiler house and iron grille doors and window guards on new tin shop, Branch workhouse, Harts Island, New York.

Canton, O.—Until noon, July 6, by Board Public Service C. A. Zellers, Clerk, for constructing about 400 squares of new roofing on auditorium.

Grafton, Pa.—Until 7:30 p. m., June 27, by E. L. McGrew, Secretary School Board, for constructing proposed addition to Third Ward school building. McCollum & Dowler, Architects, Berger Bldg., Pittsburg, Pa.

Norristown, Pa.—Until 10 a. m., July 8, by County Commissioners, Robert Miller, Clerk, for alterations to prison.

Wilkesbarre, Pa.—Until 2 p. m., June 25, by J. M. Norris, County Controller, for enlargement of county prison.

Rhinelander, Wis.—Until 2 p. m., July 10, by County Building Committee, Sam S. Miller, Secretary, for erection of a court house. C. H. Tegen, Architect, Manitowoc, Wis.

Roads and Streets.

Bids are asked on following work, the notes being arranged alphabetically by states:

Montgomery, Ala.—Until noon, June 29, by J. T. Bullen, County Engineer, for grading and covering with sand clay eight miles of the Old Pike road, south of Manne, Ala.

Washington, D. C.—Until June 30, by District Commissioners, Jay J. Morrow, Engineer Commissioner, for laying cement sidewalks.

Washington, D. C.—Until July 11, by District Commissioners, District Bldg., for constructing asphalt pavements during fiscal year (about 43,000 sq. yds.); also for 3,100 sq. yds. vitrified block gutter and 17,000 sq. yds. asphalt block pavement.

Washington, D. C.—Until noon, July 11, by District Commissioners, Jay J. Morrow, Engineer Commissioner, for paving various streets with bitulithic pavement.

Storm Lake, Ia.—Until 3 p. m., June 30, by J. E. Buland, City Clerk, for constructing street crossings and approaches of concrete. A. E. Brunson, Engineer.

Vincent, Ia.—Until 7:30 p. m., June 29, by J. B. Sells, Town Clerk, for about 2,315 sq. ft. of cement sidewalk.

Aurora, Ill.—Until 2 p. m., July 7, by Myron J. Tarble, City Engineer, for constructing 42,700 sq. yds. brick pavement and 18,400 ft. of combined curb and gutter. Official advertisement will be found elsewhere in this issue.

Crawfordsville, Ind.—Until July 11, by County Commissioners, for constructing gravel road in Brown Township.

Frankfort, Ind.—Until June 30, by Board Public Works, for paving South Main and South Clay Sts. with brick.

Indianapolis, Ind.—Until 1 p. m., July 6, by Chas. A. Miller, County Auditor, for constructing road.

Paoli, Ind.—Until 2 p. m., July 7, by E. B. Ham, County Auditor, for constructing 13,280 ft. of gravel road.

Peru, Ind.—Until noon, July 8, by Chas. Griswold, County Auditor, for constructing 18 gravel roads.

Rockville, Ind.—Until 1 p. m., July 7, by H. A. Henderson, County Auditor, for constructing gravel roads in Wabash Township.

Rockville, Md.—Until noon, July 7, by County Commissioners, Robert G. Hilton, Clerk, for grading and macadamizing about 1¼ miles of road.

South St. Paul, Minn.—Until 7:45 p. m., July 6, by John J. O'Brien, City Recorder, for grading River Road.

Camden, N. J.—Until 11 a. m., July 6, by Alfred L. Sayers, Director, for macadamizing the 2d Section of the Blackwoodtown Turnpike from Chews to Blackwood, a distance of 2.4 miles, using asphaltum oil for binder, and a separate alternate bid for the same work substituting gravel instead of asphaltum oil for binder on the 1½-in. stone. J. J. Albertson, County Engineer.

Cape May C. H., N. J.—Until noon, July 7, by A. B. Smith, Director, for constructing 2.9 miles of gravel road. R. Fendall Smith, County Engineer, Ocean City, N. J.

Elizabeth, N. J.—Until 2:30 p. m., July 3, by County Freeholders, for constructing 5,495 lin. ft. of 16-ft. wide, 8-in. macadam (9,587 sq. yds.). F. J. Hubbard, County Engineer, 201 Park Ave., Plainfield, N. J.

Salem, N. J.—Until 2:30 p. m., July 6, by John F. Ayres, Director, for constructing 4.76 miles of road. Josiah Miller, County Engineer, Salem.

New York, N. Y.—Until 3 p. m., July 2, by Park Board, Arsenal Bldg., 5th Ave. and 64th St., for furnishing all the labor and materials for reconstructing the roadway of the Eastern Boulevard, in Pelham Bay Park, including surfacing with asphaltic mixture, from the Split Rock Road to the northern boundary of Pelham Bay Park, in the Borough of the Bronx. Security required is $15,000.

New York, N. Y.—Until noon, June 29, by Allen N. Spooner, Commissioner of Docks, Pier A, for repairing asphalt pavement on North and East Rivers. Security required is $10,000.

Northport (L. I.), N. Y.—Until noon, July 2, by John Deveau, Village Clerk, for grading, regulating, paving and curbing, the work including 12,000 sq. yds. of Peekskill gravel pavement, 1,100 sq. yds. granite pavement, 1,300 sq. yds. of brick pavement, 1,400 ft. 18-in. storm sewer, 2,400 ft. bluestone curb and gutter. Frank Asbury, Engineer, Huntington (L. I.), N. Y.

Wellsville, N. Y.—Until 7:30 p. m., June 30, by Village Trustees, F. M. Leonard, Clerk, for paving with brick or block 6,160 sq. yds. and curbing with stone 3,310 lin. ft. R. H. Lee, Engineer.

Columbus, O.—Until July 1, by A. B. Critchfield, Adjutant General, for laying cement walks around State House grounds.

Lima, O.—Until noon, June 25, by Board Public Service, L. L. Crumrine, Secretary, for grading, curbing and macadamizing portion of Cole St. Certified check for $100 required with bid.

New Lexington, O.—Until noon, June 27, by Charles E. Beard, Village Clerk, for paving Water and Pleasant Sts. with brick or block. Certified check for $500 for each street required with bid.

South Newburgh (Sta. F, Cleveland), O.—Until noon, June 27, by H. H. Bohning, Village Clerk, for paving, grading and draining Hathaway Road. Ralph Hecker, Village Engineer, 426 Electric Bldg., Cleveland.

Toledo, O.—Until noon, June 29, by Board Public Service, Reynold Voit, Secretary, for paving portions Parkwood Ave., South St., Missouri St. and Islington St.

Bentleyville, Pa.—Until 4 p. m., July 6, by C. C. Hanlon, Borough Engineer, Room 3, Landafeld Bldg., Monongahela, Pa., for improvement of Main St., the work including 3,000 cu. yds. excavation, 3,500 lin. ft. curbing, 3,300 sq. yds. brick paving, 900 lin. ft. 12-in. sewer, 300 lin. ft. 8-in. sewer and one culvert with concrete covering walls.

Easton, Pa.—Until 10 a. m., June 26, by County Commissioners, L. A. Francisco, County Engineers, for reconstructing 1,600 ft. of road.

Pittsburg, Pa.—Until 10 a. m., June 26, by A. B. Shepherd, Director Public Works, for grading, curbing and paving with standard sheet asphalt parts of three streets; grading, curbing and paving with block stone, "Class D," portions of four streets; grading, curbing and paving with repressed vitrified brick portions of two streets, macadamizing Mansfield Ave. and constructing cement sidewalks on parts of three streets.

Spring City, Pa.—Until 8 p. m., June 29, by O. B. Finkbiner, Borough Clerk, for constructing 7,500 sq. yds. of brick pavement on Main St.

Wilkesbarre, Pa.—Until 2 p. m., July 6, by J. M. Norris, County Controller, for repairs to macadam road.

Chattanooga, Tenn.—Until 10 a. m., June 29, by W. L. Dodds, County Engineer, for constructing concrete sidewalk around Court House grounds.

Milwaukee, Wis.—Until 10:30 a. m., June 25, by Board Public Works, Charles J. Poetsch, Chairman, for constructing asphalt pavement as follows: On Concord Ave., certified check for $360 with bid; on Hartford Ave., certified check for $300 with bid; on Lake Drive, certified check for $2,100 with bid.

North Milwaukee, Wis.—Until 7:30 p. m., June 29, by Emil H. Klamp, Village Clerk, for constructing about 8,000 sq. ft. of cement sidewalk.

Rhinelander, Wis.—Until 2 p. m., July 7, by Board Public Works, Geo. C. Jewell, Chairman, for constructing 18,890 sq. yds. of macadam.

Sewers.

Bids are asked on following work, the notes being arranged alphabetically by states:

Paragould, Ark.—Until 9 a. m., July 1, by Board of Improvement District No. 1, R. L. Alexander, Chairman, for constructing complete sewer system and septic tank, the work including following items: (1) 34,245 lin. ft. of trench, bet. 4 ft. and 10 ft. deep. (2) 1,250 lin. ft. of trench, not over 10 ft. deep. (3) 33,355 lin. ft. of sewer pipe, ranging from 8 to 15 ins. diameter. (4) 270 lin. ft. of cast iron pipe, 8 ins. and 10 ins. in diameter. (5) 1,014 Y-connections, from 8 ins. to 15 ins. (6) 104 manholes. (7) 17 flush tanks. (8) 10 lampholes. (9) 1 septic tank, complete with pump, etc. (10) Installing of all equipment and constructing system, complete, according to the plans and specifications. W. K. Palmer Co., Engineer, 718 Dwight Bldg., Kansas City, Mo.

Eureka, Cal.—Until July 6, by F. E. Browning, City Clerk, for constructing 8-in. sewer in Mound St.

Fort Leavenworth, Kan.—Until 11 a. m., June 27, by Capt. Wm. Davis, Constructing Q. M., for the construction of storm water and subsoil drains from buildings 41, 42, 56 and 244, at Fort Leavenworth, Kan.

Iron River, Mich.—Until 8 p. m., June 29, by Jas. B. Henley, Village Clerk, for constructing sewers. Duluth Engineering Co., Duluth, Minn., are the Engineers.

Virginia, Minn.—Until 8 p. m., June 30, by Albert E. Bickford, City Clerk, for constructing sanitary sewer in Sewer District No. 1. E. E. Johnson, City Engineer.

Winnebago, Minn.—Until 8 p. m., July 2, by J. H. Sherin, Village Clerk, for constructing 3,331 ft. of 8-in. sewer.

Jefferson City, Mo.—Until 4 p. m., June 29, by E. F. C. Harding, City Engineer, for constructing sewers in subdivision B of Sewer District No. 9.

David City, Neb.—Until 8 p. m., July 8, by W. S. McCoy, City Clerk, for material and labor for constructing sewer system. M. A. Earl & Co., Engineers, 1416 First National Bank Bldg., Chicago, Ill.

Omaha, Neb.—Until 2 p. m., July 6, by Andrew Rosewater, City Engineer, for constructing brick or concrete storm water sewers as follows: Izard St. main sewer.—840 ft. sewer, 10 ft. in diameter; 860 ft. sewer, 11 ft. 3 ins. diameter; 1,440 ft. sewer, 12 ft. in diameter; 250 ft., more or less, of 16x7½ reinforced concrete construction; 80 ft. sewer, 42 ins. in diameter; 1,600 ft. sewer, 30 ins. in diameter; 150 ft. open ditch work. Jones St. extension.—121 lin. ft. 8-ft. sewer; 252 lin. ft. 5-ft. sewer; 804 lin. ft. 4-ft., 10-in. sewer; 460 lin. ft. 4-ft., 2-in. sewer.

Ashtabula, O.—Until noon, June 30, by Board Public Service, A. J. Richardson, Clerk, for constructing sewer in Lake St., the work including 612 lin. ft. 12-in. sewer, 208 lin. ft. 10-in. sewer, 280 lin. ft. 9-in., and 1,000 lin. ft. 8-in. sewer, 1,250 lin. ft. of 4-in. sewer laterals, 7 manholes, 1 manhole and flush tank. Bids are also asked for sewer in Michigan Ave., to include 492 lin. ft. of 12-in. sewer.

Cleveland, O.—Until July 23, by A. R. Callow, Secretary Board Public Service, for constructing 8½ ft. intercepting sewer from E. 12th St. to E. 20th St. Estimated cost is $60,000.

New Bremen, O.—Until noon, July 18, by F. W. Schroeder, Jr., Village Clerk, for sewering Franklin St., the work including 399 ft., 8-in., 70 ft., 10-in., 860 ft., 12-in., and 335 ft., 15-in. pipe sewer.

Painesville, O.—Until noon, July 1, by Board Public Service, Will O. Doolittle, Clerk, for constructing storm water sewer in State St., and two sanitary sewers. State St. work includes: 1,700 ft. 24-in. pipe; 640 ft. 20-in. pipe; 695 ft. 18-in. pipe, etc.

Steubenville, O.—Until noon, June 29, by Board Public Service, for constructing 20-in. vitrified pipe sewer in Stark St.

Bentleyville, Pa.—See under Bids Asked—Roads and Streets.

Pittsburg, Pa.—Until 10 a. m., June 26, by A. B. Shepherd, Director Public Works, for constructing 15-in. pipe sewers in parts of Willard St., Tyson St. and Murtland St.

Pittsburg, Pa.—Until 10 a. m., June 29, by James P. Shaw, Director, Department of Charities and Correction for the construction of sanitary sewerage and sewage disposal plant, at the North Side City Home, Werner Station. Plans, etc., at office of L. E. Chapin, No. 1017 Frick Bldg., Pittsburg, Pa.

Fort Adams (P. O. Newport), R. I.—Until 10 a. m., June 27, by Capt. Willis C. Metcalf, Constructing Q. M., for constructing 6-in. sewer at this post.

Hudson, Wis.—Until 8 p. m., July 6, by A. Karras, City Clerk, for constructing sewer in 4th St.

Merrill, Wis.—Until 7:30 p. m., June 29, by Wm. J. Kyes, City Clerk, for constructing sewer in State St.

Milwaukee, Wis.—Until 10:30 a. m., June 25, by Board Public Works, Charles J. Poetsch, Chairman, for constructing several pipe sewers.

North Milwaukee, Wis.—Until 7:30 p. m., June 29, by Emil H. Klamp, Village Clerk, for furnishing all material and labor for the construction of two filter beds 40x90x3 ft. deep.

Owen, Wis.—Until July 1, by A. R. Jones, Village Clerk, for constructing 8-in. and 10-in. sewers in several streets.

Sturgeon Bay, Wis.—Until 6 p. m., June 29, by Board Public Works, for constructing about 4,400 ft. of 8-in. to 24-in. sewer. A. C. Greaves, City Engineer.

Water Supply.

Bids are asked on following work, the notes being arranged alphabetically by states:

Cherokee, Ia.—Until 8 p. m., July 7, by Wm. Sharlow, Jr., City Clerk, for furnishing and laying about 1,600 ft. of 4 in. cast iron water pipe, etc. Official advertisement will be found elsewhere in this issue.

Ricketts, Ia.—Until 7:30 p. m., July 6, by City Clerk for construction of water works system. Plans, etc., with City Clerk. J. C. Jacobsen, Mayor.

Batavia, Ill.—Until July 6, by City Clerk, according to reports, for constructing 17,000 ft. of water mains.

Grand Haven, Mich.—Bids are being asked by Waldo Francisco, Superintendent of Public Works, for a stand pipe or reservoir, 50 to 75 ft. in diameter and 25 ft. high. Official advertisement will be found elsewhere in this issue.

Elgin, Minn.—Until 8 p. m., July 1, by Alexander Scott, Village Recorder, for the removal of the old water tower and the construction of a new steel tower, 100 ft. high, and a steel tank with a capacity of 47,000 gallons, and the furnishing and laying of 125 ft. of 6-in. cast iron water main for the village water works. Loweth & Wolff, Consulting Engineers, St. Paul, Minn.

Towner, N. Dak.—Until June 30, by City Clerk, according to reports, for constructing water works system.

Norfolk, Neb.—Until noon, June 30, by Mayor J. D. Sturgeon, for material and labor for constructing water main. Official advertisement will be found elsewhere in this issue.

Newton Falls, O.—Until noon, July 2, by Board of Service, Carl W. Smith, Clerk, for cast iron pipe, castings, fire plugs, excavation and laying 250 tons 4 in., 6 in., and 8 in. pipe, 3 tons specials, 30 fire plugs, including 20,000 lin. ft. excavation. Reliance Engineering Co., Cincinnati, O., are the Engineers.

Reading, Pa.—Until 7:30 p. m., July 10, by Water Commissioners, Edward Elbert, President, for constructing Bernhart filters. Certified check for $15,000 required with bid. Emil L. Nuebling, Engineer and Superintendent.

North Milwaukee, Wis.—Until 7:30 p. m., June 29, by Emil H. Klamp, Village Clerk, for laying about 2,000 ft. of cast iron water main, village to furnish pipe, etc.

Sturgeon Bay, Wis.—Until 8 p. m., July 7, by Henry Leonhardt, City Clerk, for construction of water works and electric light plant. A. C. Greaves, City Engineer. Official advertisement will be found elsewhere in this issue.

Excavation, Earth and Rock.

Bids are asked on following work, the notes being arranged alphabetically by states:

Bledsoe, Ark.—Levee Work.—Until July 3, by Levee Board, B. G. Covington, Chief Engineer, 168 Randolph Bldg., Memphis, Tenn., for 110,000 cu. yds. of levee enlargement work at Bledsoe.

Detroit, Mich.—Dredging.—Until 3 p. m., July 21, by Lt. Col. C. McD. Townsend, U. S. Engrs., Jones Bldg., Detroit, for dredging Hay Lake and Neebish Channels, St. Mary's River, Mich.

Glenwood, Minn.—Ditch Work.—Until 10 a. m., July 7, by Ole Irgens, County Auditor, for constructing Judicial Ditch No. 1. Estimated cost is $53,620.

New York, N. Y.—Rock Removal.—Until noon, July 17, by Col. John G. D. Knight, U. S. Engrs., Army Bldg., New York, for removing Long Rock in Harbor at Echo Bay, N. Y., and ledge rock in Bronx River, New York.

Syracuse, N. Y.—Creek Improvement.—Until 4 p. m., July 23, by Syracuse Intercepting Sewer Board, Harry J. Hamlin, Secretary for improvement of Onondaga Creek. The work covers about 2½ miles and includes 75,000 cu. yds. excavation and 17,800 cu. yds. concrete blocks and mass concrete. Official advertisement will be found elsewhere in this issue.

Danville, Pa.—Filling.—Until noon, July 9, by the Board of Trustees of the State Hospital for the Insane at Danville, for filling a portion of the Pennsylvania canal upon the grounds of the State Hospital, Danville, Pa. Plans, etc., from Dr. H. B. Meredith, Superintendent State Hospital, Danville, Pa.

Elk Point, S. Dak.—Ditch Work.—Until 2 p. m., July 9, by Chas. S. Harter, County Auditor, for constructing the Lewison ditch; certified check for $1,500 required with bid. Also for constructing the Schon ditch; certified check for $500 required with bid.

Sioux Falls, S. Dak.—Drainage Ditch.—Until 2 p. m., July 8, by C. E. Hill, County Auditor, for the construction of Drainage Ditch No. One and appurtenances, involving about 100,000 cu. yds. of excavation and 600 cu. yds. of concrete masonry. The work is located about 2½ miles northeasterly from Sioux Falls. Specifications for above work may be seen at office of Engineering Contracting, 355 Dearborn St., Chicago, Ill. Official advertisement will be found elsewhere in this issue.

Miscellaneous.

Bids are asked on following work, the notes being arranged alphabetically by states:

Orland, Cal.—Dam, Spillway, Dikes.—Until 2 p. m., Aug. 27, at the office of U. S. Reclamation Service, Orland, Cal., for the construction of East Park Dam, Spillway and Dikes, located about 12 miles northwest from Sites, Colusa County, California, and involving the placing of about 13,500 cu. yds. of concrete and the excavation of about 8,500 cu. yds. of materials. For further particulars address the United States Reclamation Service, Washington, D. C., 307 Tilford Bldg., Portland, Ore., or Orland, Cal.

Wilmington, Del.—Metal Work.—Until 11 a. m., July 10, by Light House Engineer, Wilmington, Del., for furnishing metal work for superstructure of light house at Elbow of Cross Ledge Light Station, Delaware Bay, N. J.

Wilmington, Del.—Retaining Wall.—Until 10:30 a. m., July 2, by Edw. R. Mack, Park Engineer, Lovering Ave., and Dupont St., for constructing a reinforced concrete retaining wall 276 ft. long, along Brandywine Creek at Kirkland Park, Wilmington.

Chicago, Ill.—Concrete Fence Posts.—Bids are wanted for furnishing 1,000 concrete fence posts for use on a farm on C. & N. W. Ry., near Chicago. Address A. B. G., care Engineering-Contracting, 355 Dearborn St., Chicago, Ill.

New York, N. Y.—Concrete Walls, Etc.—Until 3 p. m., July 2, by Park Board, Arsenal Bldg., 5th Ave. and 64th St., for furnishing all the labor and materials for completely erecting and constructing the concrete walls, piers and footing and reinforced concrete posts, surmounted by an electrically welded iron fence, on the Eastern Extension of Bronx Park, Security required is $10,000.

Wilkesbarre, Pa.—Street Lighting.—Until noon, July 23, by Fred H. Gates, City Clerk, for lighting certain streets with electricity for terms of three, five or seven years.

Nashville, Tenn.—Lock Gates.—Until 11 a. m., July 15, by Maj. Wm. H. Harts, U. S. Engrs., for constructing and erecting steel lower gates for Hales Bar Lock, Tennessee River.

Materials, Machines, Supplies, Tools, Etc.

Bids are asked on following work, the notes being arranged alphabetically by states:

Washington, D. C.—Stokers.—Until 2 p. m., July 1, by Committee on Buildings, U. S. Department of Agriculture, for mechanical stokers for the boiler plant, consisting of five Continental Internally Fired Boilers, of the United States Department of Agriculture, Washington, D. C.

Fort Dade, Fla.—Ice Plant.—Until 8 p. m., July 16, by Constructing Q. M., for constructing distilling and ice plant at this post.

Pensacola, Fla.—Pipe and Specials.—Until noon, July 1, by Bond Trustees, R. M. Bushnell, Chairman, for furnishing and delivering either f. o. b. cars or on wharf at Pensacola, Fla., 624 ft. of 16-in. cast-iron pipe, 3,048 ft. of 12-in., 18,576 ft. 10-in., and 756 ft. of 4-in., weighing approximately 855 tons, with about 22 tons of special castings. Also one 16-in. gate valve, 6 12-in., 17 10-in., 26 6-in. and 1 4-in. and 31 two-way fire hydrants with steamer nozzle and 51 cast-iron extension valve boxes.

Chicago, Ill.—Fire Alarm Cable.—Until 11 a. m., July 2, by William Carroll, City Electrician, 12 City Hall, for furnishing electric light and fire alarm cables in approximately the following amounts: 150,000 ft. No. 6 B. & S. G. rubber covered, lead-incased electric light cable; 18,000 ft., 50 pair, No. 19 B. & S. G. solid filled core, paper insulated, lead-incased fire alarm cable; 18,000 ft., 30 pair, No. 19 B. & S. G. solid filled core, paper insulated, lead-incased fire alarm cable; 35,000 ft., 15 pair, No. 19 B. & S. G. solid filled core, paper insulated, lead-incased fire alarm cable; 25,000 ft., 5 pair, No. 19 B. & S. G. solid filled core, paper insulated, lead-incased fire alarm cable.

Chicago, Ill.—Steel Poles, Cross Arms, Etc.—Until 11 a. m., July 1, by William Carroll, City Electrician, 12 City Hall, for furnishing the following: 2,000 25-ft. tubular steel poles, 3 in.x4 in.; 200 30-ft. tubular steel poles, 3 inx4 in.; 500 2-pin cross-arms, to fit 3-in. steel poles; 300 2-pin cross-arms, to fit 4-in. steel poles; 100 4-pin cross-arms, to fit 4-in. steel poles; 200 4-pin cross-arms, to fit 5-in. steel poles; 500 24-in. lamp brackets to fit 3-in. steel poles; 300 24-in. lamp brackets to fit 4-in. steel poles; 300 30-in. lamp brackets to fit 5-in. steel poles.

New Boston, Ill.—Pumping Plant.—Until 2 p. m., July 29, by Commissioners Bay Island Drainage and Levee District, New Boston, Ill., for furnishing and erecting a pumping plant and sluiceways, including three 250-HP. water-tube steam boilers, three 500-I.HP. horizontal compound condensing steam engines and three 60-in. centrifugal pumps, together with all foundations, appurtenances, piping, etc., necessary for complete working plant. Harman Engineering Co., Engineers, 120 Fredonia Ave., Peoria, Ill. Official advertisement will be found elsewhere in this issue.

Baltimore, Md.—Weedicide.—Until 11 a. m., July 1, by J. L. Wickes, Commissioner of Street Cleaning, for furnishing Street Cleaning Department with weedicide for destroying grass and weeds.

Detroit, Mich.—Electric Plant.—Until July 8, by Public Lighting Commission, F. T. Bowler, Secretary, for installing electric generating plant in station of public lighting plant.

White Plains, N. Y.—Electric Equipment, Etc.—Until 11 a. m., July 3, by County Supervisor, F. M. Thompson, Secretary, for labor and material in connection with following items (for which separate bids are asked), for new court house: Electric equipment of Central Power Plant, electric fixtures for new Supreme Court and new hall of records buildings, vacuum cleaner, rubber tiling, carpets and rugs, special wood furniture, metal furniture and rain water sewer. Lord & Hewlett, Architects, 345 Fifth Ave., New York.

Pittsburg, Pa.—Water Meters.—Until 10 a. m., June 26, by A. B. Shepherd, Director Public Works, for furnishing 2,400 water meters, ⅝ in. to 6 in. in size.

Williamsport, Pa.—Dump Wagons.—Until noon, June 30, by J. J. Galbraith, City Clerk, for supplying two dump wagons.

CONTRACTS LET.

The following contracts have been let recently:

Huntsville, Ala.—Railroad Grading.—W. J. Bennett & Co., Huntsville, for grading first five-mile section out of this city of roadbed for Nashville & Huntsville Ry. Contract for second five-mile section was let to E. L. Pulley and J. E. Toney.

Fort Mason, Cal.—Docks, Land Reclamation.—J. C. Carlin, New York, at $1,197,000, for constructing three transport docks and reclaiming tide flats near Fort Mason, for U. S. War Department.

Napa, Cal.—Bridge.—H. W. Wing, Napa, at $2,335, for building stone arch bridge for county.

Oakland, Cal.—Sewer.—Contra Costa Construction Co., at $18,518, for constructing branch sewer on Second St.

Des Moines, Ia.—Building Work.—Contracts for heating plants and building additions for five schools were let as follows: Oak Park, general contract, Benson & Marxer, $3,075; Bryant, general contract $2,125, plumbing and heating $1,805; McCauley Co.; Howe, heating, Fowler & Anderson, $1,640; Emerson, general contract, W. H. Brereton $2,778; plumbing, Globe Plumbing Co., $3,345; Webster, general contract, W. B. Christy $2,220; heating, Globe Heating Co. $4,115.

Rathdrum, Idaho.—Bridge.—Carscollen Bros., Coeur D'Alene, Idaho, at $3,750, for constructing bridge for county.

Bloomington, Ill.—Sewers.—Patrick McDonald, at $1,117, for sewer in Jefferson St., and at $2,943 for sewers in White Oak Road.

Champaign, Ill.—Bridge.—Burnham & Ives, Bloomington, Ill., at $3,025, for 140-ft. bridge for county; Decatur Bridge Co., at $1,360, for bridge in Colfax Township.

Cairo, Ill.—Interurban.—Contracts for construction of interurban line between Paducah, Ky., and this city have been let as follows: Grading, Simms Bros., Thebes, Ill., at $70,113; 18 bridges, Forbush & Stotler, Benton, Ill.; cars and equipment, General Electric Co., New York, $48,750. Lowest bid for power station and substations was $96,500. Charles F. Crup, Columbus, Ind., is President and J. J. Freundlich, Paducah, Ky., is General Manager.

Clinton, Ill.—Bridge Work.—Decatur Bridge Co., at $1,170, for new stone abutments and wings for bridge over Salt Creek.

La Harpe, Ill.—Bridge.—Fowler & Wilson, at $1,175, for 60-ft. bridge over Deacon Creek.

Cairo, Ill.—Filling, Dredging.—Contracts for constructing 12-in. to 20-in. pipe sewers and filling streets by hydraulic process was let to Cairo Contracting & Dredging Co., Cairo, Ill., at about $73,000. W. B. Thistlewood is City Engineer.

Monmouth, Ill.—Sewer.—A. W. Gates, at $1.35 per foot, for relaying Euclid Ave. sewer from 2d St. to 6th St.

Watseka, Ill.—Sewer.—Dandrea, Piacent & Co., Chicago Heights, at $5,323, have contract for constructing about one mile of 20-in. to 27-in. sewer for this city.

Columbia City, Ind.—Bridges.—County Commissioners have awarded contracts, amounting to $7,881, for 23 bridges, culverts and abutments. Schneider & Lilly, Columbia City, secured 11 contracts, and Frank Shively, Bourbon, secured seven.

Frankfort, Ind.—Sewers.—L. R. Kramer, for sewer in Kramer Addition; Fisher & Crawford, for Woodside sewer system.

Indianapolis, Ind.—Sewer.—Manley-O'Donnell & Co., at $1.70 per lin. ft., for local sewer in Chicago St.

New Castle, Ind.—Road Work.—C. W. Cocand and Harvey Millikan, at about $5,000, for constructing highway in Franklin Township.

Peru, Ind.—Sewer.—Anderson, Damico & Co., Peru, at $16,226, for constructing sewer for town of South Peru.

South Bend, Ind.—Sewers.—Staples & Ackerman, South Bend, for constructing Logan St. trunk sewer and 4th St. lateral; L. H. Webster, South Bend, for 2d St. sewer extension; G. Frank Stoeckinger, Mishawaka, Ind., for sewer in 2d St.

Atchinson, Kan.—Bridge.—Missouri Valley Bridge Co., at $3,671, for reinforced concrete bridge over Independence Creek.

Wellington, Kan.—Septic Tanks.—H. A. Rowland, for constructing septic tanks for this city.

Louisville, Ky.—Sewer.—L. R. Figg & Co., Louisville, at $16,443, for constructing Cave Hill cemetery sewer and drain, 3,500 ft. long.

Iron Mountain, Mich.—Sewer.—J. R. Holfeltz Co., Iron Mountain, at $13,800, for constructing extension of main sewer on Kimberly Ave.

Detroit, Mich.—Paving Work.—T. E. Currie, at $25,792, for six contracts for resurfacing brick streets; Ferd Porath, at $2,237, for two contracts, and Baker & Clancy, at $1,344, for one contract.

Mankato, Minn.—Bridge Repairs.—Twin City Bridge Co., at $1,395, for repairing Kremer bridge.

Duluth, Minn.—Road Work.—Brindos & Hoseia, at $11,100, for building 12½ miles of road extension.

Nevada, Mo.—Bridge.—A. M. Blodgett Constructing Co., at $1,538, for building steel bridge over Clear Creek for county.

Winston-Salem, N. C.—Sewer.—Capt. R. M. Bibb, Roanoke, Va., at $7,931, for constructing sewer in Liberty St.

Binghamton, N. Y.—Sewer.—John Shultz, sewer from New to High St. at $4,365. A. L. Willey, sewer from De Russay to New St. at $1,467.

Baltimore, Md. Reservoir.—Bids were received June 10 by the City Water Department, Alfred M. Quick, Water Engineer, for work under Item No. 1—constructing 225,000,000-gallon reservoir, the contract being awarded to Lane Bros. Co. & Jones, Baltimore, Md., at $494,810. The itemized bids received on this work, the bidders and the time for completion were as follows: (1) Lane Bros. Co. & Jones, 400 days; (2) Fisher-Riley & Carozza, Baltimore, Md., 700 days; (3) Eyre-Shoemaker, Inc., Philadelphia, Pa., 450 days; (4) David Peoples, Philadelphia, Pa., 400 days; (5) Fidelity Construction Co., Detroit, Mich., 600 days, (6) Stewart-Kerbaugh-Stanley Co., New York, 500 days; (7) Robt. C. Storrie, Fort Worth, Tex., 500 days; (8) Cranford Paving Co., Washington, D. C., 650 days; (9) Wm. B. Monroe, Boston, Mass., 450 days; (10) United Engineering & Contracting Co., New York, 600 days. Such bids received June 10, by City Water Department, Baltimore, Md., for construction of 225 mil. gal. reservoir:

BIDS RECEIVED JUNE 10 BY CITY WATER DEPARTMENT, BALTIMORE, MD., FOR CONSTRUCTION OF 225-MILLION GALLON RESERVOIR.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Stripping beneath dam inc. boulders	13,500 cu. yds.	$0.38	$0.375	$0.40	$0.60	$0.50	$0.70	$0.50	$0.45	$0.54	$0.34
Removing top soil	40,000 cu. yds.	.35	.35	.33	.40	.36	.50	.35	.50	.54	.50
Removing clay	80,000 cu. yds.	.30	.30	.34	.40	.50	.45	.35	.50	.54	.50
Earth excavation } from basin	273,000 cu. yds.	.20	.33	.28	.34	.28	.34	.35	.49	.40	.45
Loose rock excavation } from basin	125,000 cu. yds.	.39	.40	.40	.34	.58	.55	.55	.89	.60	1.10
Solid rock excavation } from basin	169,000 cu. yds.	.82	.85	.70	.74	.92	.81	1.25	.89	1.32	1.10
Earth excavation } shallow trench	5,360 cu. yds.	.40	.40	.43	1.50	.45	.50	.80	1.25	.50	.90
Loose rock excavation } shallow trench	1,210 cu. yds.	.80	.60	.50	1.50	.80	.70	1.50	2.50	1.75	1.50
Solid rock excavation } shallow trench	410 cu. yds.	2.00	1.50	3.50	3.50	5.00	2.00	4.00	6.40	4.00	5.00
Earth excavation } deep trench	14,000 cu. yds.	.50	1.50	2.75	3.25	2.15	.80	1.25	2.50	2.00	2.50
Loose rock excavation } deep trench	6,150 cu. yds.	1.10	2.00	3.25	5.00	3.15	1.20	1.75	3.50	2.00	3.20
Solid rock excavation } deep trench	260 cu. yds.	3.00	3.00	4.00	10.00	5.00	3.00	5.00	6.40	7.00	5.00
Backfill	20,090 cu. yds.	.18	.12	.30	.09	.50	.60	.20	.30	.30	.24
Rolled or paddled clay in trench	5,000 cu. yds.	.35	.20	.50	.45	1.00	.35	.75	.75	1.00	.60
Rolled or paddled clay in cut-off wall	3,720 cu. yds.	.35	.20	.50	.50	1.00	.35	.75	.75	1.00	.60
Rolled or paddled clay in dam	35,000 cu. yds.	.35	.15	.50	.25	1.25	.30	.70	.70	1.00	.45
Rolled selected material in dam	152,000 cu. yds.	.20	.10	.20	.16	.13	.35	.25	.30	.25	.13
Random rock and earth in dam	95,000 cu. yds.	.15	.05	.20	.10	.07	.35	.15	.15	.15	.11
Top soil hauled and spread	30,000 cu. yds.	.30	.50	.36	.29	.38	.50	.35	.45	.45	.34
Top soil rolled and seeded	75,000 sq. yds.	.03	.05	.10	.06	.03	.10	.05	.07	.15	.05
Slope paving—Els. 340-353	15,700 sq. yds.	1.60	1.30	2.00	.60	1.20	1.75	.50	1.50	1.25	2.20
Slope paving Els. 330-340	3,670 sq. yds.	1.80	1.80	2.00	.50	1.10	2.00	.50	1.70	1.25	3.00
Slope paving Els. 320-330	2,000 sq. yds.	2.00	1.90	2.25	.45	1.00	2.50	.50	1.80	1.25	3.20
Slope paving below El. 320	2,000 sq. yds.	2.10	2.25	2.35	.45	1.00	2.50	.50	1.95	1.25	3.60
Plain concrete in cut-off wall	560 cu. yds.	8.00	6.00	7.00	9.00	6.65	8.00	9.00	6.90	9.00	8.00
Reinforced concrete in cut-off wall	2,060 cu. yds.	10.00	15.75	16.25	28.00	20.20	18.00	12.00	11.60	12.00	27.00
Plain concrete in bonding wall	210 cu. yds.	8.00	7.00	7.25	10.00	9.25	8.00	9.00	7.90	9.00	12.00
T. & G. sheeting left in trench	100,000 ft. b. m.	50.00	37.00	18.00	28.00	35.00	50.00	40.00	30.00	75.00	54.00
Plain sheeting left in trench	80,000 ft. b. m.	40.00	35.00	15.00	30.00	32.00	40.00	35.00	17.00	25.00	40.00
8-in. Vit. sewer pipe } furnishing and laying, only	500 lin. ft.	.40	.25	.36	.30	.48	.30	.30	.30	.30	.30
12-in. Vit. sewer pipe } furnishing and laying, only	500 lin. ft.	.60	.65	.70	.40	.66	.50	1.00	.47	.50	.60
18-in. Vit. sewer pipe } furnishing and laying, only	1,475 lin. ft.	1.00	1.00	.90	1.00	.96	.80	1.50	.80	.95	1.00
12-in. Vit. tile, furnishing and laying, inc. stone or gravel	1,490 lin. ft.	.60	1.00	.75	.60	.60	.90	1.00	.55	.85	.72
Storm water inlets, complete	[illegible]	55.00	75.00	60.00	55.00	25.00	50.00	50.00	31.00	50.00	42.00
Gate house substructure											
Gate vault											
48-in. reinforced concrete conduit	1,010 lin. ft.	7.00	4.05	8.25	5.75	5.70	5.00	6.00	3.50	7.50	9.00
1:2 cement grout	500 bags cement	.75	1.00	1.15	.40	1.00	.50	1.00	.70	1.00	1.00
Neat cement grout	100 bags cement	.65	.90	.95	1.00	.75	.60	1.25	.65	1.00	.75
Total		$494,810.00	$530,469.00	$589,414.00	$590,375.00	$650,875.00	$654,109.00	$663,236.00	$760,450.00	$774,679.00	$837,241.00

Baltimore, Md. Diversion Sewer.—In connection with the construction of the reservoir, noted elsewhere in these columns, bids were received June 10 by the City Water Department, Alfred M. Quick, Water Engineer, for work under Item No. 2, construction of a diversion sewer, the contract being awarded to C. B. Clark & Co., Baltimore, Md., at $33,572. The bid, the bidders and the time for completing the work were as follows: (1) Lane Bros. Co. & Jones, Baltimore, Md., 150 days; (2) C. B. Clark & Co., Baltimore, Md., 200 days, (3) Eyre-Shoemaker, Inc., Philadelphia, Pa., 100 days, (4) David Peoples, Baltimore, Md., 150 days; (5) Reiley & Riddle, Lancaster, Pa., 150 days; (6) Stewart-Kerbaugh-Shanley Co., 500 days, (7) Robt. C. Storrie, Fort Worth, Tex., 300 days, (8) Cranford Paving Co., Washington, D. C., 650 days, (9) Wm. B. Munroe, Boston, Mass., 250 days; (10) United Engineering & Contracting Co., New York, 600 days (11) Albert Weber, Baltimore, Md., 200 days, (12) Falvey & Kelly, Boston, Mass., 120 days, (13) Metropolitan Contracting Co., Baltimore, Md., 200 days. Bids received June 10 at Baltimore, Md., for constructing a concrete diversion sewer:

BIDS RECEIVED JUNE 10 AT BALTIMORE, MD., FOR CONSTRUCTING A CONCRETE DIVERSION SEWER.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Earth excavation	7,540 cu. yds.	$0.50	$0.60	$1.50	$0.90	$0.90	$1.00	$1.25	$1.54	$1.90	$2.50	$0.80	$1.25	$2.80
Loose rock excavation	1,700 cu. yds.	1.10	1.20	1.75	1.50	.90	1.50	1.75	2.74	2.50	3.20	1.25	2.25	3.50
Solid rock excavation	3,360 cu. yds.	2.00	2.75	3.50	4.00	3.25	2.50	3.00	3.95	6.00	4.00	2.25	5.50	5.50
Sheeting left in trench	20,000 ft. B. M.	10.00	40.00	15.00	25.00	40.00	40.00	35.00	17.00	25.00	10.00	30.00	20.00	25.00
6-in. Vit. tile in place	500 lin. ft.	.10	.25	.55	.30	.50	.40	.75	.20	.50	.32	1.25	.50	.35
18-in. Vit. sewer pipe in place	350 lin. ft.	1.00	.50	.90	.80	1.00	.80	1.25	.70	1.00	.90	1.60	2.00	1.50
60-in. concrete sewer	753 lin. ft.	11.00	6.25	8.00	9.00	7.60	8.50	9.00	8.40	7.25	15.00	9.00	7.00	10.00
39-in. concrete sewer	1,283 lin. ft.	15.00	7.25	9.80	11.50	9.40	12.50	12.00	11.03	8.00	16.00	11.00	8.00	12.75
Bell mouth complete														
Stepped "Drop" section	51 lin. ft.	35.00	26.00	45.00	25.98	20.00	30.00	22.00	30.00	35.00	25.00	25.00	15.00	20.00
Sewer manholes	78 lin. ft.	4.50	6.75	6.50	5.00	4.00	6.00	5.00	5.90	7.00	7.50	4.25	6.00	7.00
Manhole frames and covers	5	25.00	11.00	14.00	17.50	12.00	25.00	15.00	30.00	25.00	25.00	18.00	16.00	18.00
Inlets and connections complete	5	85.00	97.00	40.00	85.00	60.00	60.00	125.00	133.00	75.00	200.00	27.00	3.00	225.00
Overhaul	5,000 c. yds. 100 ft.	.01	.00¾	.02	.02	.01	.03	.02	.00¾	.25	.01	.09	.01	.05
Total		$44,524.00	$33,572.00	$49,129.00	$48,164.00	$40,461.00	$45,081.00	$49,177.00	$54,103.00	$60,130.00	$73,563.00	$40,923.00	$50,243.00	$73,986.00

South Orange, N. J.—Bridge.—Schwier & Sutton, New York, at $[illegible] for building bridge at Baker St.

Merchantville, N. J.—Sewer Work.—B. F. Sweeten & Co., Camden, N. J., at $57,300, for completing sewer system.

Troy, N. Y.—Tree Spraying.—E. T. Schoomaker, Cedar Hill, N. Y. Spraying Elm trees at $1 per tree.

Herkimer, N. Y.—Sewer Work.—Fred H. Stevens, furnishing sewer pipes and fittings for storm sewers at $2,850.

New York, N. Y.—Reinforced Concrete Stairs.—Turner Construction Co., 11 Broadway, New York, has been awarded the contract for constructing all the reinforced concrete stairs on the Manhattan approach of the Blackwells Island Bridge. The work will be undertaken at once.

Rochester, N. Y.—Paving.—Whitmore Rauber & Vicinus, brick pavement on Stewart St.

Syracuse, N. Y.—Bridge.—Canton Bridge Co., steel bridge over French Creek at $18,000.

Struthers, O.—Dam.—W. T. Smith, Warren, O., concrete dam, 140 ft. wide, 30 ft. high, 4 ft. at the base and 2 ft. at the top.

Portsmouth, O.—Bridge.—Louie Bower, Flemingsburg, Ky., repair of the wooden bridge across the Little Scioto River at $2,186.

Collinsville, O.—Bridge.—Frank J. Davis, repair of abutment of a bridge at $1,908.

Portsmouth, O.—Sewer.—J. A. Grimes, sanitary sewer in alley between Second and Third Sts., from Gay to No. Waller St., and between Third and Fourth Sts., from Chillicothe to Washington Sts.

Lorain, O.—Sewers.—R. Bellamy, for the construction of sewers on Fifth and Bromwell Sts., and Faragher and Randall, a sewer on Apple St. Harry Glover was awarded contract for delinquent sewer connections on Washington St.

Hamilton, O.—Sewers.—Joseph Guilliame, for the building of the third section of the Crawford Run Sewer, at $46,800.

Chillicothe, O.—Sewer.—Jardine, Brewer & Tomlinson, for the building of Honey Creek Sewer, amounting to about 3,000 ft.

Chillicothe, O.—Bridges.—The Capital Construction Co., for the building of a new bridge between Hallsville and Adelphlin, L. E. Wiley & Son, for the building of the Dry Run abutment on the Richmondale pike.

Springfield, O.—Shop Building.—The Eilenberger Construction Co., for the erection of the three new shops for the Superior division of the American Speeding Machine Co., at about $50,000.

Barberton, O.—Storm Sewer.—Paul & Henry, for constructing storm sewer for Cornell and adjoining streets.

Stroud, Okla.—Railroad Work.—P. J. McNerny, Carthage, Mo., at about $95,000, for constructing 45 miles of roadbed from Sapulpa to Stroud, Okla., for Frisco.

Philadelphia, Pa.—Bridges.—Contracts for bridge work for city have been let as follows: 42d St., Owego Bridge Co., at $76,950; 61st St., Carey & Reed, $27,990; Northeast Boulevard, Cramp & Co., $25,325.

Mont Alto, Pa.—Water Works System.—W. G. Fritz & Bro., York, Pa., at $25,509, for constructing water works system for state sanitarium at Mont Alto. Work consists of constructing reinforced concrete reservoir of 300,000 gallons capacity, two concrete collecting wells, two triplex pumps driven by 8 h. p. engines and 20,000 ft. of cast iron pipe lines.

Knoxville, Tenn.—Sewer.—John L. O'Connor, at $11,820, for the construction of the extension to the First Creek sewer main, some 7,000 ft. long, using 18, 15 and 12 in. vitrified pipe, except in some few points where it was found necessary to use cast iron. S. D. Newton is City Engineer.

PROJECTED WORK.

Bridges.

Items Arranged Alphabetically by States.

Fresno, Cal.—County Commissioners have granted Kings River Power Co., represented by A. L. Selig, Los Angeles, Cal., extension of time until November, 1904, for commencing work on the construction of a bridge at Trimer Springs. Bridge will cost about $10,000.

Council Bluffs, Ia.—Bill has been passed authorizing the construction of a third bridge over the Missouri River between Council Bluffs and Omaha.

Dubuque, Ia.—Matter of constructing viaduct over the Milwaukee tracks in the 5th Ward may come before City Council.

Kamiah, Idaho—Kamiah Bridge Co. has been granted franchise for a toll bridge over the Clearwater River at this place, and will open bids for its construction early in July. Bridge will be combination wood and steel truss structure and will cost about $10,000. The substructure will be rock cribbed piers.

Greenup, Ill.—Town has voted $3,500 for repairing bridge over Ambarras River.

Aurora, Ind.—Commissioners of Dearborn and Ohio Counties have decided to erect a new bridge over Loughery Creek on the county line. Estimated cost is $18,000.

Fort Wayne, Ind.—County Commissioners will probably locate new bridge to be built in this city at Riverside Ave.

West Springfield, Mass.—Boston & Albany R. R., according to reports, is to widen its bridge over Main St., Merrick, so that it will carry four tracks.

Carleton, Mich.—Exeter Township, Monroe County, has voted to issue $4,000 of bonds for repairing and building new bridges.

Eaton Rapids, Mich.—Election was held June 22 to vote on raising $2,500 additional for building bridge over Grand River.

Marshall, Mich.—George Champs, C. E., Toledo, O., is preparing plans for new bridge for this town to replace the one washed away last spring. Bridge will cost about $6,500.

Springfield, Mo.—City Engineer has completed plans for bridges over the Jordan at Boonville St. and at Main St. Boonville St. will be 30 ft. span, 60 ft. wide of reinforced concrete.

Reading, Pa.—County Commissioners are to erect bridge over Swatara Creek, connecting Bethel and Tulpehocken Townships.

Omaha, Neb.—City Council has approved plans of Andrew Rosewater, City Engineer, for a steel viaduct to be erected by the C., B. & Q., the Union Pacific and Great Western Rys., over their tracks from 30th and Walnut Sts. to 26th and Bancroft Sts.

Coyle, Okla.—Commissioners of Logan and Payne Counties are to construct jointly a steel bridge over the Cimarron at a probable cost of $75,000.

York City, Pa.—County Commissioners will let contracts in July for a 70-ft. steel bridge over north branch of Bermudian Creek in Washington Township, and for a 40-ft. bridge over Cadorus Creek. It is also proposed to erect a 100-ft. steel bridge over Little Conewago Creek between Manchester and Conewago Townships.

Easton, Pa.—Commissioners of Northampton and Lehigh Counties are reported to be calling for bids for the joint county bridge to be erected at Broad St., Bethlehem.

Williamsport, Pa.—Grand Jury has reported in favor of constructing following bridges: Over second fork of Larrys Creek in Mifflin Township, over Laurel Run, in Moreland Township, and over Muncy Creek, in the borough of Picture Rocks.

Wilkesbarre, Pa.—Following were low bidders June 8, for erection of several county bridges: Ashley Borough, concrete, Geo. Cooksey, $495; Ashley Borough, steel, Geo. Cooksey, $495; White Haven Borough, stone arch, Peter J. Clark, $800; Black Creek Township, steel over Black Creek, Penn Bridge Co., $12,393; Nescoped Creek Township, steel and concrete, Thomas Haines, $641; Plains Township, steel and concrete, Thomas Haines, $1,172; Slocum Township, stone arch, Abraham Vanauken, $560; Ross Township, stone arch, Jasper Swingle, $745; Butler Township, steel and concrete, Thos. Haines, $674; Hunlock Township, stone arch, Jasper Swingle, $449; Kingston Township, stone arch, Alvah Roushey, $385; Wright Township, steel and concrete, Thos. Haines, $1,451; Franklin Township, stone arch, L. F. Hayman, $297; Hunlock Township, steel and concrete, Andrew Croop, $405; Franklin Township, stone arch, W. S. Hoover, $285; Lake Township, stone arch, Jasper Swingle, $300; Hollenback Township, steel, Penn Bridge Co., $1,749; Conyngham Borough, concrete, A. J. Harter, $589; Wilkesbarre, steel and concrete, Thos. Haines, $1,767; Dallas Township, stone arch, Jasper Swingle, $525; Jackson Township, stone arch, Alvah Roushy, $375; Dorrance Township, stone arch, Abraham Vanauken, $640; Duryea Borough, steel, Penn Bridge Co., $7,491; Kingston Township, steel and concrete, Thos. Haines, $1,595; Union Township, stone arch, Thos. Haines, $1,475.

Railroads

Items Arranged Alphabetically by States.

Trinidad, Colo.—Construction work is stated to have been started on the Colorado, Hereford & Gulf R. R. The line as projected is to be 1,500 miles long, connecting Trinidad, Hereford, Big Springs, San Angelo, San Antonio and Port Lavaca, Texas.

Louisville, Ga.—The construction of a railroad from this city east to a point on the Savannah River, about 40 miles, is proposed by the Cotton Belt R. R., now being organized in Georgia.

Coeur D'Alene, Idaho.—F. B. Morrill, Receiver for the B. R. Lewis Lumber Co., has been authorized to lay eight miles of rails from the end of the Idaho & Northwestern R. R., for the purpose of getting out logs. Right of way has been graded and ties cut for track.

Evergreen, Idaho.—Pacific & Idaho Northern R. R. is planning an extension from its present terminus at this city to Roseberry and from that point into the Long Valley country.

Clinton, Ill.—Surveys are under way for the proposed cut-off of the Chicago & Northwestern R. R., from East Clinton to Union Grove, Whiteside County, Ill. The cut-off will eliminate a bad grade and will shorten the line one mile.

Salina, Kan.—Hal W. Neiswanger, Osborne, Kan., is reported to be promoting project for the construction of a line of railroad from Salina to Osborne.

Madisonville, Ky.—Construction work has been resumed on the Madisonville, Hartford & Eastern R. R., which is to extend from Madisonville to Fordsville. Most of the grading has been completed and the bridges nearly completed. Geo. M. Feagin, Hartford, Ky., is Chief Engineer.

Alexandria, La.—Alexandria, Leesville, Lufkin & Western R. R., organized to construct a line to connect Alexandria and Leesville, La., and Lufkin, Tex., has elected the following officers: Michael O'Brien, President; Thos. C. Wingate, Vice President; J. J. Hicks, Second Vice President; W. K. Ferguson, Third Vice President; G. H. Switzer, Secretary; J. E. Duff, Treasurer. H. H. White is Counsel at Alexandria, and D. M. Shollars is Counsel at Leesville. Capital stock is $1,000,000.

Jackson, Miss.—New Orleans, Mobile & Chicago R. R. Co., mentioned in our last issue, has been chartered, and it is stated that construction work will be begun in the near future on its line, which will run from Ovett, Miss., 140 miles in a southwesterly direction to New Orleans. The road is a Mobile, Jackson & Kansas City R. R. project, the officers of it being also connected with that road. The directors of the new road are W. F. Owen, G. W. Crary, H. M. Wood, W. H. McIntosh and J. C. Rich, all of Mobile, Ala.

Omaha, Neb.—Local press reports quote S. C. Nelson, assistant to the Vice President of the Omaha & Nebraska Central Ry., as stating that construction work on the Omaha end of the line will be started soon. Preliminary surveys have been made and practically all necessary right of way received.

Shelton, Neb.—Construction of a railroad from Prosser northwest to Shelton and up the Buckeye Valley to a point west of Pleasanton, is proposed by Kearney parties, for whom E. H. Morey, C. E., Kearney, Neb., has been making preliminary investigations.

Cortland, N. Y.—Construction work for the Cortland & Auburn R. R. is to be started soon at Cortland, according to reports.

Schenectady, N. Y.—Construction work on the New York state end of the Delaware & Eastern R. R. is to be started in July, according to advices from the city. It is planned to complete the line this summer from Middleburg, Schoharie County, to Grand George, and from Grand George to Margaretville, and from East Branch to Hancock, giving a continuous rail connection between the latter place and Schenectady, a distance of about 150 miles. The middle section of the road in Pennsylvania is now under construction. The Delaware & Eastern Construction Co. was recently incorporated with a capital stock of $200,000 by William Seibert and D. Fleurerstein, Brooklyn, N. Y., and Wm. A. Relyea, New York.

Knoxville, Tenn.—Work has been started on the first section from Knoxville to Servierville, 26 miles, of the Knoxville, Servierville & Eastern Ry. This work is stated to have been started so as to secure a bond issue voted by Servier County. It is also stated that final plans have been completed and contracts will be let shortly for the whole work. The proposed line in Tennessee is to be 52 miles, and it may be extended into North Carolina.

Memphis, Tenn.—Surveys are partially made for the Arkansas Pacific Ry. Co., and Mangum, Okla., reports quote Geo. D. Locke, President, as stating that construction contracts may be let in October. The line as proposed is to run from Memphis, Tenn., via Fort Smith, Ark., Tulso and Lehigh, Okla., to Denison and Abilene, Tex., with a branch from Lehigh to Mangum, Okla., and from there to Roswell, N. Mex. The total length of the proposed line is 1,500 miles.

Spokane, Wash.—Phoenix Lumber Co. and Washington Water Power Co. are to jointly build a 23-mile standard gage steam railway between Little Falls on the Spokane River, where the power company is erecting a hydro-electric plant, and Springdale for the Spokane Falls & Northern Division of the Great Northern Ry.

Tacoma, Wash.—The Pacific & Southeastern R. R., incorporated a short time ago by Gen. Hubbard and other stockholders of the Pacific Improvement Co., of which Gen. J. M. Ashton is State Agent, has opened offices here to direct the work of surveying and building the railroad from the Tacoma water front across the Cascade Mountains. Surveys are now being made up Voight Creek to reach the new workings of the Carbon Hill Coal Co., a subsidiary of the Pacific Improvement Co. The first section of the new railroad will run to these mines.

Port Arthur, Ont.—Mayor J. J. Carrick, M. P. P., of Port Arthur, and James J. O'Connor, James A. Little, J. A. Crozier and W. S. Ruttan, also of Port Arthur, have applied for a charter for the Southwestern Ry. Co. They propose to build a line from a point on the international boundary at or near the Kootenay River up the valley to Elke, B. C., thence northeasterly following the valley of the North Kootenay River and the South Fork of the Old Man River to Cowley, Alberta; thence to the Livingstone range to Highwood River and on to Calgary. The capital stock of the company is to be $1,000,000 and the bonding power is to be $40,000 per mile. The head office of the company is to be at Port Arthur.

Electric Railways.

Items Arranged Alphabetically by States.

Little Rock, Ark.—Committee, consisting of Dr. O. P. Robinson, W. B. Smith, C. N. Alexander and J. M. Rose, has been appointed to take steps for resuming building an interurban line between this city and Pine Bluff.

Paragould, Ark.—Local capitalists are taking steps to construct an interurban railway from that town to St. Francis in Clay County, running parallel with the Cotton Belt R. R. The proposed route will take in the towns of Marmaduke, Rector, Greenway and Piggott.

Huntsville, Ala.—Local electric railway is to be extended to the fair grounds, one mile north of city.

Los Angeles, Cal.—Los Angeles Ry. Co. has secured franchise for a double track electric railway on 7th St. from Broadway to Boyle Ave., and on Boyle Ave. to Hollenbeck Ave., and thence on Hollenbeck Ave. to the eastern city limits.

Redlands, Cal.—John H. Fisher, Redlands, has secured franchise for electric railway from city limits to Redlands Junction. He represents the Redlands Central Ry., a projected line to Riverside.

Ventura, Cal.—T. C. Carnahan has been granted franchise for railway through A St., Oxnard, from the southern to the eastern boundaries of that city, and to connect with the Bakersfield & Ventura R. R., which runs to Hueneme, to Round Mountain on the east and to the Paterson ranch on the west. The road is to be built in connection with the John Burson line, and reports state that gasoline cars are to be used.

Stockton, Cal.—A committee, J. R. Koch, Chairman, has secured right of way for 23 miles for a proposed electric railway from this city to Modesto.

Hueneme, Cal.—Press reports state that contracts are to be let at once for building the third five-mile section of the Hueneme, Port Los Angeles & Malibu line. Ten miles of the road are already in operation.

Denver, Col.—Colorado Interurban Construction Co., 1515 Tremont, Denver, is said to be preparing to begin work on the construction of an interurban line from Denver to Greeley, passing through Jersey, Hazeltine, Brighton, Fort Lupton, Platteville, La Salle and Evans. Right of way and franchises have been obtained and necessary capital is reported to be assured.

New Haven, Conn.—The Berkshire Street Ry. Co. will ask the legislature of Massachusetts for permit to construct a railway to connect the system with the summit of Greylock Mountain, extend its lines south from Great Barrington through the town of Sheffield to the Connecticut line and connect this extension with the town of Egremont. The New York, New Haven & Hartford R. R. will do the $2,000,000 financing involved in the consolidation.

Ottumwa, Ia.—Ottumwa Traction & Light Co. will relay about a mile of track below Ash St.

Red Oak, Ia.—At the annual meeting of the stockholders of the Red Oak & Northwestern Interurban Ry. Co., B. B. Clark, Red Oak, was elected President. The company proposes to build an interurban railway from Red Oak through Grant, Greenfield, Stuart, Redfield, Adel, Waukee and to Des Moines.

Nez Perce, Idaho.—Practically $50,000 has been subscribed toward building an 11-mile electric railway here. Z. A. Johnson is interested.

Paducah, Ky.—Contracts for the construction of the interurban line between Paducah and Cairo have been let and grading work is to be commenced at once. The road will be 38 miles long, across a level country, and will have 18 bridges. Passengers will be ferried into Cairo. The road will be equipped with six motor passenger cars, two express cars and one electric engine. The officers of the interurban are: Charles P. Crump, Columbus, O., President; F. N. Whitesides, Columbus, Vice President; L. B. Whiteside, New York, Secretary; G. O. Buram, Paducah, Treasurer; J. J. Freundlich, Paducah, General Manager.

Pittsfield, Mass.—Pittsfield Electric Street Ry. Co. has been granted franchise for an electric railway through the town of Hancock.

Grand Forks, N. Dak.—Ordinance is before Council to grant E. J. Lander, W. H. Kelsey, F. H. Kent, O. A. Webster and John Dinnie, Grand Forks, a franchise to construct a street railway system.

Omaha, Neb.—Omaha & Nebraska Central Ry., according to reports, will commence work early in July at South Omaha on its proposed electric line to Hastings. Right of way has been secured. The road will pass through Omaha, Ralston, Chalco, Wahoo, David City, Shelby, Osceola, Rising City, Swedehome, Stark, Swedeburg, Aurora, Giltner, Trumbull and Hastings. The first section of the road will be from South Omaha to Ralston, and it is planned to have cars running between these two points in the early fall. The company is incorporated under the laws of Nebraska with a capital stock of $1,500,000.

Fort Worth, Tex.—Press reports state that St. Louis capitalists have arranged to build the Fort Worth-Mineral Wells interurban. The line will be 70 miles long. The road was started lass fall, but work was stopped owing to court litigation.

Seattle, Wash.—Seattle-Tacoma Short Line, Merle J. Wightman, President, has made final location of the projected double track interurban line between Seattle and Tacoma, and all of the right of way between Seattle and the town of Des Moines has been secured. Grading work on a section of the line is already under way.

Cheyenne, Wyo.—Thomas A. Cosgriff, President First National Bank, has been granted 25-year franchise here for electric railway. Construction work will probably be started shortly.

CONTENTS OF JUNE 17, ISSUE OF ENGINEERING-CONTRACTING.

EDITORIAL:

The Educational Advertisement and Why the Interest in It is Perennial.363
The Limitations of Concrete as a Material for Columns................364

CONCRETE SECTION:

Some examples of European Use of Concrete Piles in Wharf and Dock Work 364
Some of the Methods of Cuban Block Makers and Cement Workers.......365
A High Cost for a Reinforced Concrete Lining of a Canal...........366
A Comparison in Economy of Reinforced Concrete, Cast Iron and Steel Column Construction 366
Cost of Rubble Concrete in the Granite Reef Dam of U. S. Reclamation Service 368
A Concrete Bucket Designed for Depositing Concrete in Narrow Forms.368

EARTH AND ROCK SECTION:

An Excess Curve of Quantities of Trapezoidal Canal Sections.........369

GENERAL SECTION:

Proposed New Rooms of Western Society of Engineers.................370
Method of Laying Tar Rok Sub Floors 373
A Deep Well Water Supply..........373

LETTERS TO THE EDITORS:

The Ethics of the Ashokan Reservoir Controversy 371

METHODS AND COSTS:

Shooting Wells—Stopping Holes in Steel Conduit—Data on Sewage Purification at Providence, R. I.—Checking Earth Slides.............372

THE
NEW YORK CONTINENTAL JEWELL
FILTRATION COMPANY
FILTERS
General Contractors
CHICAGO NEW YORK

Contractors' Supplies and Heavy Hardware
Lead Furnaces
Jute Packing
Joint Runners
Calking Tools
All Kinds of Castings to Order
SCOVIL MFG. & SUPPLY CO., 609-611 Greenwich Street New York City

ESTABLISHED 1820
YOUNG & SONS
MANUFACTURERS OF
ENGINEERING MINING AND
SURVEYING INSTRUMENTS
PHILADELPHIA

CONCRETE PAVEMENTS.

Bozeman, Montana

Sealed proposals will be received at the office of the undersigned in the City of Bozeman, Montana, until 7:30 o'clock p. m. on the 2d day of July, 1908, for the construction of concrete pavements on Main street in said city from Wallace avenue to Fourth avenue, twenty-five thousand (25,000) square yards, more or less.

Said proposals shall be for doing the work in accordance with the plans and general specifications on file in this office, and which may also be seen at the office of the City Engineer.

Each proposal must be accompanied by specifications in detail as to the proposed method of construction and materials to be used.

Proposals should be made upon the forms attached to the general specifications and must be accompanied by a certified Chicago check for one thousand ($1,000) dollars, payable to the City Treasurer of the City of Bozeman.

The right is reserved to reject any or all bids. By order of the City Council, June 4th, 1908.

H. H. HOLLOWAY,
City Clerk.

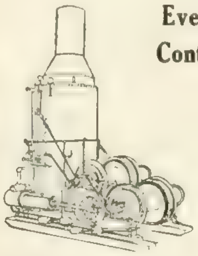
24-3t

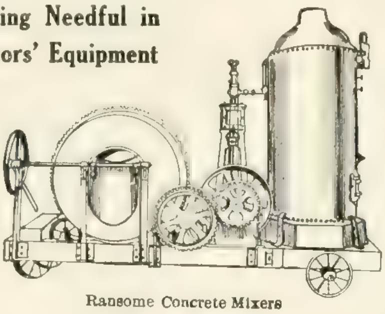
In a Hurry?—Send to Hough

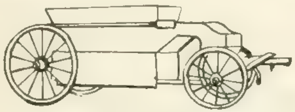
EXPEDITION FOR CONTRACTORS

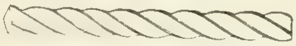
in the completion of work is made possible by our ability to ship from our big new warehouse

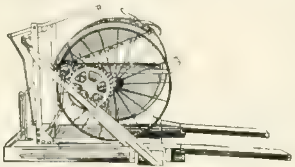
Everything Needful in Contractors' Equipment

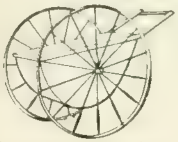

Buffalo Hoisting Engines

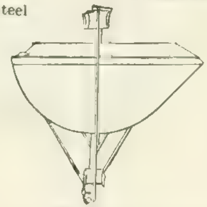

Ransome Concrete Mixers


Troy Wagons

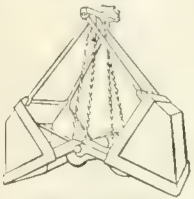

M-B Cold Twisted Steel

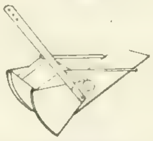

Street and Sidewalk Concrete Mixers

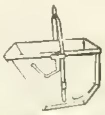

Ransome Concrete Carts


Automatic Dump Concrete Hoist Buckets

Swivel Concrete Cars

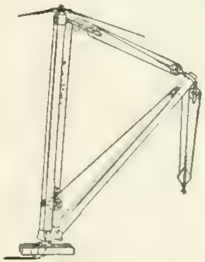

Hercules Clam Shell Buckets

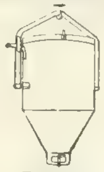

Sand, Stone and Concrete Bin Gates

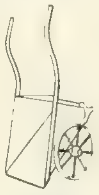

Self-righting Buckets

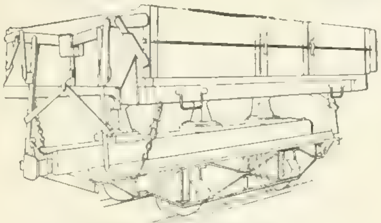
Hercules Orange Peel Buckets

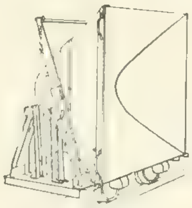
Balanced Cableway Cranes


Derricks


Bottom Discharge Concrete Buckets


Charging Barrows


Peteler Two-way Dump Cars


Two-way Side-Dump Concrete Cars

These cuts illustrate only a part of our complete line.

We are furnishing plants for every conceivable contractors' purpose. Probably we can suggest some better way of doing your work.

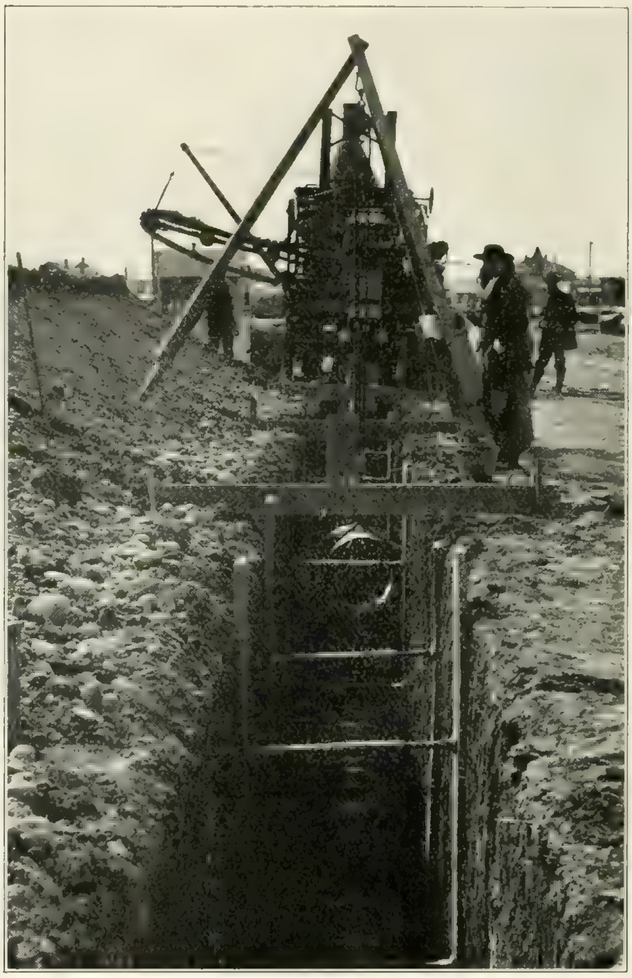
Our machinery is built to stand up under severe service. It is **always on the job doing the work.**

Why not finish your job on time and at a profit. We can help you do it.

Write or wire us your requirements.

William B. Hough Company
Monadnock Block
CHICAGO U. S. A.

WHEN you buy a Trench Excavating Machine of the G. W. Parsons Company, they will not only tell you what the machine will do, but they will prove to you what it will do before asking you to pay for the same. The machines are sold outright under guarantee as to what they are and what they will do. They are not experiments; they are tried and up-to-date, and are being used by some of the most successful contractors for sewers and water mains in this country and Canada.



This Machine cuts a ditch or trench of any width between 28 and 60 inches and any depth to 20 feet, and at a single cut, depositing the earth on one or both sides of the trench. The Parsons Traction Trench Excavator is easier handled, weighs less, is cheaper and in fact there are so many advantages gained by using the Parsons machine that cannot be mentioned in an advertisement, that we ask you to write for CATALOG EC, and we will gladly furnish you such information as desired.

Geo. F. Lambert, Sales Manager,
306 Observatory Building,
DES MOINES, IOWA.

Manufactured by The G. W. Parsons Company, Newton, Iowa.

Edson Diaphram Trench Pumps

THE EDSON PUMP

was the FIRST **DIAPHRAGM PUMP** ever made. Experience counts for something. IT is the accepted STANDARD all over the world.

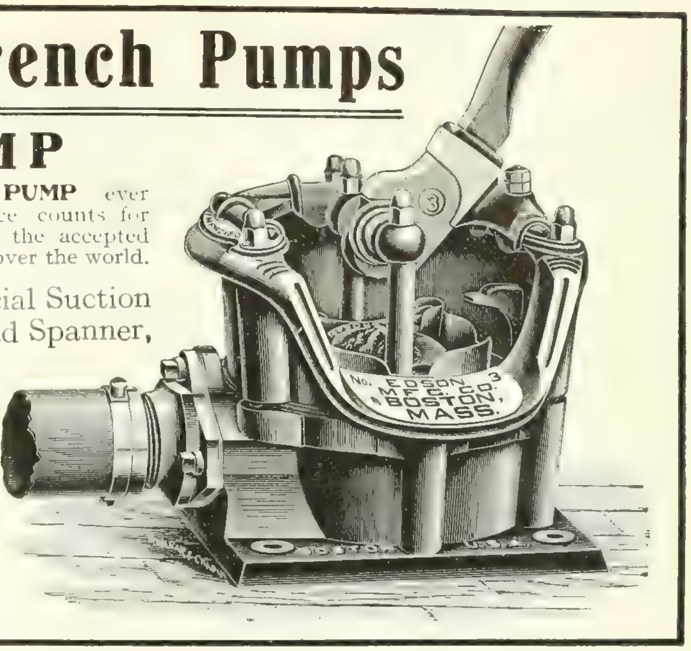
Complete Outfits, including Pump, Edson Special Suction Hose, Extra heavy Brass Couplings, Strainer and Spanner, **ready for business.** Extra lengths of **Suction Hose,** guaranteed **Diaphragms** and duplicate Pump parts, **carried in stock.**

[SEND FOR DESCRIPTIVE CATALOG

Established 1859

EDSON MFG. CO.

256 Atlantic Avenue Boston, Mass.


3
No. 3
EDSON MFG. CO.
BOSTON, MASS.

SANITARY SEWERS.

Waterloo, Seneca Co., N. Y.

Sealed proposals will be received by the President of the Village of Waterloo, N. Y., until noon of July 1st, 1908, for furnishing the materials and constructing a system of sewers with sewage disposal plant for said village. The work will cover about fourteen miles of vitrified pipe, six to twenty inches, with trenching for same, four to sixteen feet deep, with manholes, flush tanks, river crossing and septic tank. Proposals will be received for the sewers and septic tank, separately and combined.

Plans, specifications and form of contract may be obtained of the Village President or from the engineers, Morrison & Farrington, Syracuse, N. Y.

Proposals must be accompanied by certified check for two thousand dollars that bidder will execute contract; and contractor will furnish bond for twenty thousand dollars for due performance of contract. The right to reject any and all bids is reserved.

June 4, 1908.

JOHN KROPF,
24-3t Village President.

ELECTRICAL AND PUMPING MACHINERY.

—ALGIERS SEWERAGE STATION "C"—
Office of the Sewerage and Water Board,
602-604 Carondelet street, New Orleans, La., April 14th, 1908.

Sealed proposals will be received until 3 o'clock p. m., Tuesday, June 30th, 1908, for furnishing and erecting the following machinery:

2—100 K. W. 250 volt, direct current generators.

2—75 H. P. 250 volt motors.

1—2,500,000 gallon turbine pump, to work against a 125 foot head, directly connected to an electric motor.

1—1,000,000 gallon triplex pump, to work against a 125 foot head, geared to an electric motor.

1—2,000,000 gallon centrifugal pump unit, to work against a 20 foot head.

2—4,000,000 gallon centrifugal pump units, to work against a 20 foot head.

2—5 H. P. 250 volt motors.

1—Surface condenser, capable of condensing 6,500 pounds of steam per hour; together with air pump.

Also all exhaust and water piping, valves, wiring, switchboard, lights, and other appurtenances, completely erected.

Specifications with blank form of proposals may be obtained at the office of the Board. Plans will only be furnished upon personal application.

A certified check on a New Orleans bank, in the sum of $1,000, deposited in accordance with the terms of the specifications will be required of each bidder.

A surety company bond in an amount equal to 25 per cent. of the gross amount of the contract, with a surety company doing business in the State of Louisiana and acceptable to the Sewerage and Water Board, will be required of the successful bidder.

The right is reserved to reject all bids

F. S. SHIELDS,
GEO. G. EARL, Secretary.
General Superintendent. 17-10t

ELECTRIC LIGHT AND WATER-WORKS PLANT.

Sturgeon Bay, Wis.

Notice is hereby given that sealed proposals will be received by the City Clerk of the City of Sturgeon Bay, Wis., at his office until 8 o'clock p. m., July 7th, 1908, for the construction of an electric light and waterworks plant as follows:

Bids will be received for furnishing materials and constructing the plant complete, also separate bids for machinery and material delivered f. o. b. cars Sturgeon Bay, Wis.

TENDERS WILL ALSO BE RECEIVED FOR THE OLD MACHINERY NOW IN USE IN THE CITY ELECTRIC LIGHT PLANT.

Plans and specifications are on file and may be seen at the office of the City Clerk, also at the office of A. T. Maltby, 803 Great Northern Building, Chicago, Ill. Instructions to bidders will be furnished upon request.

By order of the Council. June 18th, 1908.

H. C. LEONHARDT,
26-2t City Clerk.

CONCRETE POSTS.

Chicago, Ill.

Proposals are wanted for furnishing 1,000 concrete fence posts for use on a farm on C. & N. W. Ry., near Chicago. "A. B. G.," care of Engineering-Contracting, 355 Dearborn St., Chicago.

DRAINAGE DITCH.

Sioux Falls, So. Dak.

Sealed proposals will be received at the office of the County Auditor of Minnehaha County, in the City of Sioux Falls, South Dakota, until two o'clock p. m., July 8, 1908, for the construction of Drainage Ditch Number One and appurtenances, or items thereof, as contained in the specifications, involving about 100,000 cubic yards of excavation and 600 cubic yards of concrete masonry. The work is located about two and one-half miles northeasterly from Sioux Falls, South Dakota.

Specifications and forms of proposal may be obtained from, and plans may be inspected at, the office of the County Auditor, Sioux Falls, South Dakota; the office of Samuel H. Lea, State Engineer, Pierre, South Dakota; the office of J. H. Gates, attorney for said Board, Sioux Falls, South Dakota; or at the office of the newspaper in which this notice is published.

Each bid must be accompanied by a certified check for $250, payable to the order of the Chairman of the Board of County Commissioners of Minnehaha County, South Dakota, as a guaranty that the bidder will, if successful, promptly execute a satisfactory contract and furnish a bond in the sum of 20% of the estimated contract price for the faithful performance of the work.

The right is reserved to reject any or all bids. All proposals must be made upon the blank forms of proposal prescribed by said Board.

Dated, Sioux Falls, South Dakota, June 12, 1908.

THOS. McKINNON,
Chairman Board County Commissioners.
Attest: C. E. HILL,
25-3t County Auditor. (Seal.)

PROPOSALS WILL BE RECEIVED at the Bureau of Navigation, Navy Department, Washington, D. C., until 12 o'clock noon, July 15, 1908, and there publicly opened immediately thereafter, for the Heating and Electrical Distribution Mains and Concrete Tunnel at the Naval Training Station, Great Lakes, near North Chicago, Ill. Blank forms and proposals and specifications will be furnished and plans may be procured upon application to the Commandant, Naval Training Station, Great Lakes, North Chicago, Ill. J. E. PILLSBURY, Chief of Bureau, June 4th, 1908. 25-4t

AUTHORITATIVE OPINIONS ON

"Concrete Construction--Methods and Cost"

The new book by

HALBERT P. GILLETTE and CHARLES S. HILL

"THE literature of concrete has devoted itself mostly to design, that coming primarily in the study of a new subject, but the need of a book on construction is apparent. The new one noted in the head-piece above is the first comprehensive work of the kind, and as such, should have a large circulation, * * * * * The authors have collected, from the technical press and society papers, and largely from their own personal investigation, a vast number of examples of concrete work. * * * * * In addition to these specific examples the authors have added, in connection with every branch of work, general instructions deduced from observation and formulas for quantity and cost estimates. * * * * * As would be expected from at least one of the authors a large portion of every page is given up to cost data. * * * * * Undoubtedly too much is made of such data by many, but nevertheless there is a certain value, for purposes of estimate and comparison, in well collated cost figures which warrant their publication, and those presented by Messrs. Gillette and Hill will be found to be worthy of reference many times over. * * * * * We believe every concrete designer and constructor should have a copy."—*Engineering News.*

"THE authors have given us twenty-five chapters on reinforced concrete (and plain concrete also), beginning with methods and cost of selecting and preparing materials for concrete, and ending with a chapter on the live subject of waterproofing. They have collected practically everything of real value that has appeared in print in technical periodicals within the past few years. In addition they have inserted matter that would never have been printed if they had not gone out after it. They have also commented on features that struck them as worthy of comment in the works under review. The result is a book on the economics of concrete construction that should have an immense sale.

Every engineer today has more or less concrete work to do, some in the design and more in the construction. Therefore, every engineer will find it to his advantage to possess a copy of this book, for it does not take the place of any book thus far published. It supplements all, for there is not one word on design, and the descriptive part is such as one would expect from a man who was itching to boss the job while he looked on and was not preparing a newspaper description. It is this practical treatment on every page that appeals to the reviewer and should appeal to every man who handles concrete. * * * * For a first book on a particular phase of a subject, it is remarkably complete and so deserving of recommendation that we can well skip criticism.

In the opinion of the reviewer it is worth several times the price even to an old experienced concrete man, and such the reviewer considers himself. The paper, illustrations and typography leave nothing to be desired and the book is substantially bound, as is to be expected of works from the house issuing it."—*Journal of the Western Society of Engineers.*

The book has 700 pages and 306 illustrations of forms, tools, machinery, etc., used in concrete construction.

Price, $5 Net, Postpaid

Write for 16-page pamphlet showing table of contents and sample pages.

The Myron C. Clark Publishing Co.

13-21 PARK ROW, NEW YORK
355 DEARBORN STREET, CHICAGO

CREEK IMPROVEMENT.

Syracuse, N. Y.

Sealed proposals for the improvement of Onondaga Creek, Syracuse, N. Y., will be received at the offices of the Syracuse Intercepting Sewer Board No. 112, Court House, Syracuse, N. Y., until four o'clock p. m., July 23, 1908.

The work covers approximately 2 1-3 miles in length. Its principal items are 76,000 cubic yards excavation and 14,800 cubic yards concrete blocks and mass concrete.

Proposals must be made upon blanks which will be furnished upon application. They must be accompanied by New York draft or certified check upon a Syracuse bank for $10,000.00 that the successful bidder will execute contract within five days after award to him.

Drawings, specifications and form of contract are on file at the offices of the Board, where they may be examined. Copies thereof will be furnished with any further information.

HARRY J. HAMLIN,
26-3t Secretary.

WATER MAIN.

Norfolk, Nebraska.

Sealed bids will be received by the City Council of Norfolk, Neb., up to 12 o'clock noon of June 30, 1908, for constructing water main on the following streets: North Thirteenth Street, from Koenigstein Avenue to Nebraska Avenue; east on Nebraska Avenue from Thirteenth Street to Tenth Street.

Bids to include material and labor. Plans and specifications on file at office of the City Clerk. The Council reserves the right to reject any or all bids. A certified check for 5 per cent of bid must accompany all bids.

J. D. STURGEON, Mayor.
ED. HARTER, Clerk. 26-1t

WATER SYSTEM EXTENSIONS.

Cherokee, Iowa.

City of Cherokee, Iowa, wishes sealed proposals for furnishing and laying 1,600 feet of four-inch cast iron water pipe; also desires bids for furnishing the 1,600 feet of four-inch pipe without laying.

Bids will also be received for the same amount of two-inch galvanized iron pipe under same conditions as above.

Plans and specifications can be obtained from the City Clerk.

Bids must be filed in office of City Clerk before 8 o'clock p. m., July 7, 1908, on which date the bids will be considered by the Council.

Council reserves the right to reject any and all bids.

Dated at Cherokee, Iowa, June 12, 1908.

WM. SHARDLOW, JR.,
26-1t City Clerk.

NOTICE TO CONTRACTORS AND BUILDERS OF BOILERS, STEAM ENGINES, GAS ENGINES AND CENTRIFUGAL PUMPS.

New Boston, Ill., June 11, 1908.

1. Sealed bids will be received by the Commissioners of the "Bay Island Drainage and Levee District No. 1, County of Mercer, and State of Illinois," at their office in New Boston, Illinois, until 2 o'clock p. m., Wednesday, July 29th, A. D. 1908, at which time and place said bids will be publicly opened; said bids shall be for furnishing and erecting a pumping plant and sluiceways, including three 250 H.P. water tube steam boilers, three 500 I.H.P. horizontal compound condensing steam engines and three 60-inch centrifugal pumps, together with all foundations, appurtenances, piping, etc., necessary for complete working plant as described in detail in the specifications therefor on file with the Secretary of said Commissioners. Alternate bids will also be received for gas producers and gas producers and gas engines instead of steam boilers and steam engines.

2. Bids will be received and considered upon any one or more of the parts of said work as described in the plans and specifications hereinafter mentioned, and any bidder may submit alternate bids based upon two or more parts of the work being awarded to him, but the consideration of such alternate bids by the Commissioners will not restrict their right to determine as to the lowest and best bid on each part.

3. The envelopes containing the bids shall each be plainly addressed to the "Commissioners of Bay Island Drainage and Levee District No. 1," and each shall show plainly upon the outside the name of the bidder and the facts that the envelope contains bid, plans or description.

4. Plans and specifications are on file and may be seen at the office of the Commissioners of said District in the City of New Boston, Illinois; at the office of the Harman Engineering Co., Engineers, 120 Fredonia Ave., Peoria, Illinois, and at the office of the Secretary of the Western Society of Engineers, Monadnock Bldg., Chicago, Illinois. Copy of the Specifications, Form of Contract, Form of Bid and Form of Bond may be procured by application to the Engineers above mentioned.

5. Payments will be made in cash as follows, viz.:

On Parts I, II and III, 25% of the contract price upon receipt of bill of lading showing shipment from the factory; 25% of the contract price when the same shall be placed upon the foundations ready for installation; 25% of the contract price when ready for operation; the remainder of the contract price upon final acceptance, after the testing of the plant.

On Part IV, in full within 30 days after the arrival of the gates at destination in good order.

On Part V, upon the arrival of the apparatus at destination in good order, 50% of the contract price thereof; upon completion of the same ready for operation, and acceptance after testing said apparatus, the remainder of the contract price.

On Part VI, payments will be made monthly between the 10th and 15th of each month to the extent of 75% of the value of the work completed during the preceding calendar month, as shown by the estimates of the Engineer; the remainder of the contract price upon the final acceptance of the work.

6. The Commissioners reserve the right to reject any or all bids.

R. H. ROBERTS,
D. S. PRENTISS,
M. F. PROUTY,
Commissioners, New Boston, Illinois.
HARMAN ENGINEERING CO.,
Engineers,
120 Fredonia Ave., Peoria, Illinois. 25-2t

STAND PIPE OR RESERVOIR.

Grand Haven, Mich

The City of Grand Haven, Mich., is about to erect a standpipe or reservoir on top of a hill 1,500 feet from pumping station; size to be from 50 to 75 feet in diameter, 25 feet high; to be built of steel and erected on a concrete foundation; to be connected with a 12-inch cast iron pipe from pumping station. Pipe to be laid below frost line, approximately 4½ feet deep.

Bidders are expected to make plans and specifications from a sketch prepared by the Superintendent of Public Works, Grand Haven, Mich.

26-4t WALDO FRANCISCO, Supt.

STREET IMPROVEMENT.

Aurora, Illinois

Sealed proposals will be received by the Board of Local Improvements, until 2 o'clock p. m., July 7th, 1908, for brick paving and combined curb and gutter.

Estimated quantities:
18,400 ft. combined curb and gutter.
42,700 yds. brick pavement.

MYRON J. TARBLE,
26-1t City Engineer.

CLEANING AND PAINTING BRIDGE

Cedar Rapids, Iowa.

Bids are wanted for cleaning (by sand blast or other apparatus) and repainting five spans of highway bridge.

BARTLETT & KLING,
26-1t Contractors.

U. S. ENGINEER OFFICE, Vicksburg, Miss., May 13, 1900. Sealed proposals for building Lock and Dam No. 2 in Ouachita River at Harrisonburg, La., will be received here until 12 m., July 13, 1908, and then publicly opened. Information furnished on application. CLARKE S. SMITH, Capt. Engrs. 25-4t

U. S. ENGINEER OFFICE, Duluth, Minn., June 10, 1908. Sealed proposals for dredging in Duluth-Superior harbor will be received here until noon, June 30, 1908, and then publicly opened. Information on application. GRAHAM D. FITCH, Major Engrs. 25-2t

THE JOHNSON
Well Screen
All sizes. Brass. Large Capacity.
Non-choking. Used everywhere.
WRITE FOR BOOKLET "EC."
E. E. JOHNSON, St. Paul, Minn.

NATURE ADORNED
My booklet gives some interesting data on what may be accomplished in beautifying and improving the landscape Engineers, city and railroad officials should send for it.
F. R. MEIER, 1 Broadway, NEW YORK
Consulting Forester

Prompt Shipments

BEST EXTENSIBLE TRENCHING BRACE MADE
KALAMAZOO, FDRY. & MACHINE CO MICHIGAN
508 EAST MAIN ST.

YOU
are asked to help us to increase our influence among engineers and contractors, not already subscribers to our paper.
Send Us Their Names

CONTRACTORS AND ENGINEERS
USE
Nash's Expeditious Measurer
A book of 200 pages of indexed tables, showing at a glance the cubic contents of any stone or package according to its length, breadth and depth. Used by Contractors, Quarrymen and Engineers everywhere. Order of your bookseller or the publisher. $2.00 Postpaid.
A. L. NASH
17 State Street NEW YORK
Send for Sample Pages
SAVE LABOR
SAVE TIME
AVOID ERRORS

WANTS

Undisplayed Cards under
this heading cost only
One Cent a Word
Displayed $1.00 an Inch.

TECHNICAL MEN superintendents, engineers and draftsmen. Openings in all parts of the world at the highest possible salaries. Write us today of your experience. **Hapgoods**, 305 Broadway, New York City, or Suite 1012 Hartford Building, Chicago.

WANTED—Catalogs and booklets pertaining to municipal and general engineering. D. L. Yarnell, Asst. City Engineer, Le Mars, Iowa. 24-4t

WANTED—Engineering-Contracting for Jan. 9, 1907, to complete volume for binding. Address A. V. Saph, 2158 Blake St., Berkeley, Calif. 25-2t

WANTED—MEN—Soft ground tunnel foreman and laborers, Louisville, Ky. Long job and good wages. Address The E. G. Nave Bros. Co., Story and Bickle Aves., Louisville, Ky. 24-4t

WANTED, POSITION—Tunnel Superintendent open for engagement, with complete organization for rock, soft ground and compressed air, shields included. Address "Tunnel Supt.," care Engineering-Contracting, 13-21 Park Row, New York. 25-4t

WANTED—Position as superintendent or foreman of concrete construction. Several years' experience. Middle or Southern States preferred, but will go anywhere. Address Box 414, Jackson, Tenn.

WANTED—Position as foreman on bridge or building work after June 5. Fifteen years' experience bridges, foundations, factory buildings and reinforced concrete bridge work. Address Box 36, care Engineering-Contracting, 355 Dearborn St., Chicago, Ill. 22-4t

WANTED—Position as cement physical tester, concrete foreman or inspector with municipality or contractor, by young engineer now in charge of experimental laboratory of large cement plant. Address Box 38, care Engineering-Contracting, 355 Dearborn St., Chicago. 23-4t

WANTED—Position as Mechanical Draftsman by young engineer with 4 years' experience. Willing to commence with moderate salary where opportunity to learn and advance is offered. Address Box 37, care Engineering-Contracting, 355 Dearborn St., Chicago. 22-2t

WANTED—Position.—By young engineer with two years' experience in general field work and drafting. Good draftsman and instrument man. Position desired offering permanency of location. Assistant in city preferred. Address Box 35, care Engineering-Contracting, 355 Dearborn St., Chicago. 21-6t

WANTED—Position as construction engineer or contractor's superintendent, by graduate civil engineer 28 years old. Five years' experience on design and erection of structures of steel and reinforced concrete. Best of references. Address Box 34, care Engineering-Contracting, 355 Dearborn St., Chicago.

WANTED—Position. Technical graduate, age 26, wishes permanent or temporary position. Four years' exprience in state highway, municipal and mill construction and maintenance work. Small salary to start if there is chance for advancement. Address Box 39, care of Engineering-Contracting, 355 Dearborn St., Chicago. 24-2t

WANTED—Will pay 15 cents each for one perfect copy of Engineering-Contracting for each of the following dates: July 3, 1907; July 10, 1907; August 7, 1907. These papers are wanted to complete files for binding. All reading pages must therefore be in perfect condition. Address "P. V. C.," care Engineering-Contracting, 355 Dearborn St., Chicago. 21-tf

WANTED—POSITION — Constructing Engineer; will be through present work about July 15; can design, build, manage and superintend; will take an interest in good proposition if desired. Graduate of M. I. T., Jr. Am. Soc. C. E. Good connections. Further references on request. Location immaterial. Address "E. F. K.," 2520 Le Conte Ave., Berkeley, Calif. 26-4t

WANTS

Undisplayed Cards under
this heading cost only
One Cent a Word
Displayed $1.00 an Inch.

WANTED—Good second-hand leveling instrument. State make and price in first letter Address L. G. Heller, Bridgeton, N. J. 26-2t

WANTED, POSITION—Civil engineer (34), graduate, eight years' experience as instrumentman, draftsman and assistant engineer, steam and electric railway location and construction, extensive land surveys, installation of coal mining plants, masonry, desires position with railway company, mining company or contracting engineer. Address Box 41, care Engineering-Contracting, 355 Dearborn St., Chicago, Ill. 25-2t

STUDY OUR
CONCRETE
COURSES
Reinforced Concrete Design; Concrete Construction and Contracting.
CIRCULAR EXPLAINS
CONCRETE ENGINEERING
584 Caxton Bldg., Cleveland

FOR SALE

1 Kearns **Revolving Excavator,** 1½ yard Orange-Peel Bucket, 65 ft. boom.

Two 36" gauge **Saddle Tank Locomotives,** 12 ton.

One 15 ton, 36" gauge **Saddle Tank Locomotive.**

New light rails and standard section **relayers** of all weights.

BLOCK=POLLAK IRON CO.,
Chicago Cincinnati St. Louis
Yards, East Chicago, Indiana

FOR SALE
4 Sea Going Suction Hopper Dredges

Capable of dumping at sea or pumping ashore without alteration.

One of 1,500 cu. yds. hopper capacity. Three of 500 cu. yds. hopper capacity each.

Built of iron and in first-class condition; fully equipped with modern machinery, electric lighting, etc.

Address C. L. CRANDALL,
307 Trust Bldg. Galveston, Texas

J. F. GRAHAM
(Roadmaster Graham)
RAILROAD LABOR AGENT
All classes of Laborers in Any Number
SUPPLIED FREE
Competent Foremen a Specialty.
Services Guaranteed Satisfactory.
WRITE OR WIRE
204 Washington Avenue South
MINNEAPOLIS, MINN.

FOR SALE
One 5-ton
One 3-ton
One 10-ton
Rollers
Good as New
J. A. DONAHUE, 300 Old Colony Bldg., Chicago

FOR SALE—GREAT BARGAIN
TWO BUCKEYE
Traction Ditcher Machines.

One machine cuts a trench 24 inches wide by 7½ feet deep; has been used 4 months; at full depth it digs from 400 to 600 feet per day.

The other machine cuts a trench 15 inches wide by 5½ feet deep: for laying tile in fields; digs from 825 to 1650 lineal feet per day; has been used one year.

These machines have the latest improved patented leaning device (patented Jan. 7, 1908).

Will also sell patent, allowed May 25, 1908, for self-tiling and quicksand protection.

Going out of business on account of ill health; will give a bargain.

T. De Young & Sons, So. Holland, Ill.

FOR SALE OR RENT

Two Vulcan **shovels,** 1¼ yard and 2½ yard, 3 sets engines.

Two 42" gauge saddle tank 9 x 14, **locomotives,** saddle tank.

Two 36" gauge **locomotives,** saddle tank, 9 x 14.

30 and 56 lb. **relayers** with plates.

Traction engines, hoisting engines, pumps, etc.

HARPER MACHINERY COMPANY
1861 Fulton Bldg., Hudson Terminals,
50 Church Street, New York
Yards and Shops, Bloomfield N. J.

FOR SALE
One Sioux City Corliss Compound Tandem
ENGINE
14x26x36, Fly Wheel 25¾ inch face,
14 ft 4 in diameter.
Three 72 inch by 18 feet return flue
BOILERS
Address L. D. WRIGHT,
Water Commissioner, Fremont, Nebraska

FOR SALE

- 1 Carson **Trench Machine.** Fine condition. Cost new $3,000.00. Will sell for.................... **$1,700**
- 1 ¾-yd. Smith **Mixer** on trucks, with engine.
- 10 1-yd. K. & J. **Scrapers.** Fine shape.
- 2 1½-yd. Oliver rotary **Cars.** Cheap.
- 1 8-wheel **Locomotive,** just overhauled and in fine condition. Price..... **$2,000**

Write us for anything you may be needing in the line of Contractors' equipment.

R. G. LUCAS & CO.
MARION, OHIO.

The Cincinnati Frog & Switch Co.

CINCINNATI, OHIO

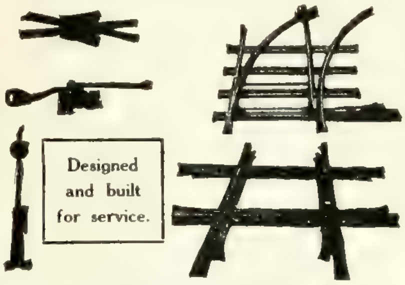
Manufacturers of

Frogs, Crossings, Switches, Switch Stands, Rail Braces,

And special track work of every description for Railroads, Mines, Mills, Contractors, Plantations.

FROGS, SWITCHES, CROSSINGS

Stands and Portable Track for all weights of rail for Quarries, Mines, Coal Tipples, Industrial Plants and Contractors' use.



Designed and built for service.

Catalogue and prices upon request

THE INDIANAPOLIS SWITCH & FROG CO.

SPRINGFIELD, OHIO

RARE BARGAINS in RAILS and EQUIPMENT

WALTER A. "ZELNICKER" SUPPLY CO.

in ST. LOUIS

Do you receive our Stock Lists?

LOCOMOTIVES

Eight 9x14 saddle tank 36-inch gauge. Also lighter and heavier locomotives. Have 165 locomotives from 6 to 70 tons in stock in our shops.

Also Steam Shovels

Southern Iron & Equipment Co.

ATLANTA, GA.

Largest Dealers in Rebuilt Equipment in United States

EAST WORKS

New Freight and Passenger Cars

WEST WORKS

Rebuilt Coaches, Cars and Engines

Hicks Locomotive & Car Works

General Offices	Eastern Representatives	Sales Dept.
Chicago Heights, Illinois		Fisher Building Chicago, Ill.

Empire Steel & Equipment Co., 141 Broadway, New York.

Steam Shovels, Locomotives, Cars, etc.

Contractors' and Railway Equipment

Telegraph, Telephone or Write Us.

A. C. TORBERT & CO.

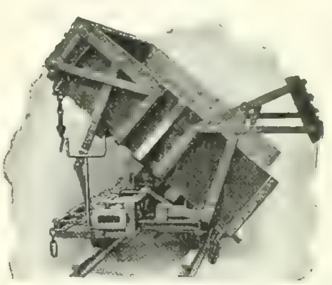
647-548 Monadnock Block CHICAGO

VULCAN IRON WORKS

CHICAGO

PILE DRIVERS

"CONTINENTAL" DUMP CARS



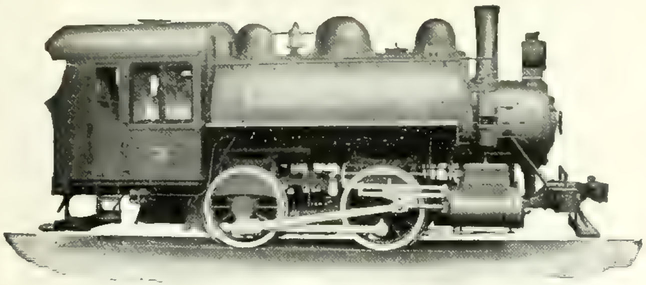
1½ to 20 Cubic Yards Capacity, any Guage.

Continental Car & Equipment Co., (Inc.)

17 Battery Place, New York

Highland Park, Louisville, Ky.

LIGHT LOCOMOTIVES



For contractors, mines, plantations, industrial plants and light switching service generally.

Standard types in stock for immediate shipment. Any desired design built to suit purchasers' requirements.

Interchangeable spare parts always on hand.

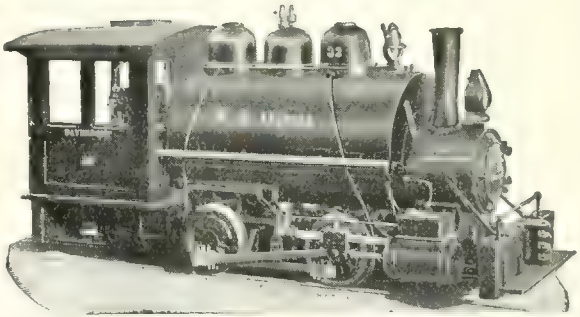
AMERICAN LOCOMOTIVE COMPANY

30 Church Street, New York

Davenport Contractors' Locomotives

Excel in Hauling Capacity as well as in working and wearing qualities—That's why sc many contractors use them exclusively

We build a contractor's locomotive—not merely a locomotive that can be used by contractors. This being our business, we have made it a point *to learn* by study and experiment the things that a contractor wants in a locomotive, and after learning, *to provide* these needed things in **Our Locomotive.** A contractor's locomotive has hard usage, and not the best care—good material and good workmanship are, therefore, essential, and we provide both. A contractor's locomotive must have hauling capacity—we guarantee **Davenport Locomotives** to haul more, size for size of cylinders, than any other. A contractor's locomotive has to be simple and easy to repair — **Davenport Locomotives** have interchangeable parts, and these parts are always kept in stock. We demonstrate all these claims in our Catalog "EC." Send for it, and if you are ever in Davenport come and see our plant—we feel proud of it.



DAVENPORT LOCOMOTIVE WORKS, Davenport, Iowa

List of Contractors' Supplies.

If you wish the catalogs of the leading manufacturers of any tool or machine mentioned below, send us a postal card, giving your address and business, and the list number of article of which you want catalogs.

This will save you the trouble of writing several letters to different manufacturers. Should you later on have correspondence direct with the manufacturers, we shall apppreciate it if you will state in your letters that you are indebted to ENGINEERING-CONTRACTING for the introduction. Such a statement will be mutually beneficial.

2 Asbestos.
4 Asphalt.
6 Asphalt plants.
7 Asphalt tools.
8 Augers, pneumatic.

10 Ballast spreaders.
12 Balast unloaders.
14 Bearing, ball and roller.
16 Bearings, self-oiling.
18 Bellows.
20 Belt dressing.
22 Belting, canvas.
24 Belting, chain.
26 Belting, leather.
28 Belting, rubber.
30 Blacksmiths' tools.
31 Blasting batteries.
32 Block machines, cement and concrete.
33 Blocks, tackle.
Blowers. See 180.
36 Blue print machines.
38 Boilers.
39 Boiler covering.
40 Brakes, air.
42 Brick, building.
44 Brick, paving.
45 Brick machines.
46 Bridges.
48 Buckets, clam shell.
50 Buckets, dumping.
52 Buckets, orange peel.

60 Cableways.
62 Cars, ballast.
64 Cars, dump.
66 Cars, flat.
68 Cars, hand.
69 Cars, mining.
70 Carts. See also 520.
72 Carts, concrete.
73 Castings, brass.
74 Castings, iron.
76 Castings, steel.
Cement block mach. See 32
80 Cement pipe molds.
82 Cement walk tools.
84 Cement, natural.
86 Cement, Portland.
88 Chains, common.
90 Chains, sprocket.
91 Channelers.
92 Clocks, time.
93 Chimney construction.
94 Compressors, air.
95 Conduit, bituminous fiber.
Concrete reinf. See 474.
Conduit, vitrified. See 142.
96 Concrete fence post molds.
97 Computing machines.
98 Contractors' bonds.
100 Contractors' supplies.
102 Conveying machinery.

104 Cranes.
106 Cranes, locomotive.
108 Cranes, traveling.
110 Creosoting.
112 Crossings, railway.
114 Crushers, rock.
116 Culverts.

120 Derricks and fittings.
Draftmen's instrs. See 154.
124 Dredges.
126 Drill sharpeners.
Drills, air. See 136.
128 Drills, core.
130 Drills, diamond.
132 Drills, pneumatic plug.
134 Drills, ratchet.
136 Drills, rock.
138 Drills, well.
140 Dynamite.
142 Ducts, vitrified.
Dump wagons. See 520.
144 Dynamos.

Electric motors. See 324.
152 Elevators, bucket.
154 Engineers' instruments.
156 Engines.
158 Engines, gas.
160 Engines, gasoline.
162 Engines, hoisting.
164 Engines, steam.
166 Engines, traction.
167 Expansion bolts.
168 Expanded metal.
169 Expanders, tube.
170 Exploders.
172 Explosives.

180 Fans or blowers.
182 Felt.
184 Fence and railing.
186 Filters, water.
187 Fireproof doors, partitions.
188 Flanges, steel.
190 Flue lining.
192 Flush tanks.
194 Forges, blacksmith.
195 Forms for concrete work.
196 Frogs.
198 Fuel economizers.
Fuse. See 170.

210 Garbage furnaces.
212 Gates and valves.
214 Gears and pinions.
216 Governors, engine.
218 Governors, water wheel.
220 Graders, elevating.
222 Gaskets.
224 Grubbers.

228 Hammers, pneumatic.
230 Hangers, joist.
232 Harness.
234 Hoists, air.
236 Hoists, chain, differential.
238 Hoists, electric.
240 Hoists, gasoline.
242 Hoists, horse-whim.
244 Hoists, steam.
246 Horse feed-bags.
248 Hose.
250 Hydrants.

260 Injectors.
261 Insulated wire.
262 Iron.
264 Iron, corrugated.
266 Iron, sheet.

270 Jacks, hydraulic.
272 Jacks, screw.
274 Jacks, track.
Jacks, trench. See 502.

280 Laborers supplied.
282 Lamp posts.
284 Lathe, metal.
286 Lights, contractors'.
288 Lime.
290 Locomotives, dinkey.
292 Locomotives, electric.
294 Locomotives, gasoline.
296 Locomotives, geared.
298 Locomotives, steam.
300 Lubricants.
302 Lumber, creosoted.

310 Machine tools.
312 Manganese steel.
314 Manhole covers.
315 Metaline.
316 Meters, water.
318 Mineral wool.
319 Mining machinery.
320 Mixers, concrete.
322 Motors, compressed air.
324 Motors, electric.
326 Motors, water.

330 Nickel steel.
332 Nuts and nut locks.

330 Oilless Bearings.

340 Packing.
341 Painting machines.
342 Paints.
344 Paving blocks, stone.
Paving bricks. See 44.
348 Picks.
350 Pile drivers.
352 Pile driver jets.
354 Piles, concrete.
356 Piles, interlocking, steel.
358 Piles, creosoted.
360 Pipe covering.
362 Pipe, cast iron.
364 Pipe, cement.
366 Pipe, lead.
368 Pipe, riveted steel.
370 Pipe, vitrified sewer.
372 Pipe, wrought iron.
374 Pipe cutting machine.
375 Pipe tapping machines.
376 Plows.
Plows, unloading. See 12.
Pneumatic tools. See 8, 132, 416.
380 Portable railways.
382 Powder, black.
383 Prism glass.
384 Pulleys.
386 Pumps, diaphragm.
388 Pumps, electric.
392 Pumps, sand.
394 Pumps, steam.
396 Pumps, trench.
398 Punches, hydraulic.

400 Quarry bars.

406 Railroad signals.
410 Rails, new.
412 Rails, second hand.
413 Railway track layers.
414 Rammers, pneumatic.
415 Recording instruments.
416 Riveters, pneumatic.
418 Road machinery.
Rock crushers. See **114**.
422 Rollers, horse.
424 Rollers, steam.
425 Roofers' supplies.
426 Roofing.
427 Rope drive.
428 Rope, manila.
430 Rope, wire.

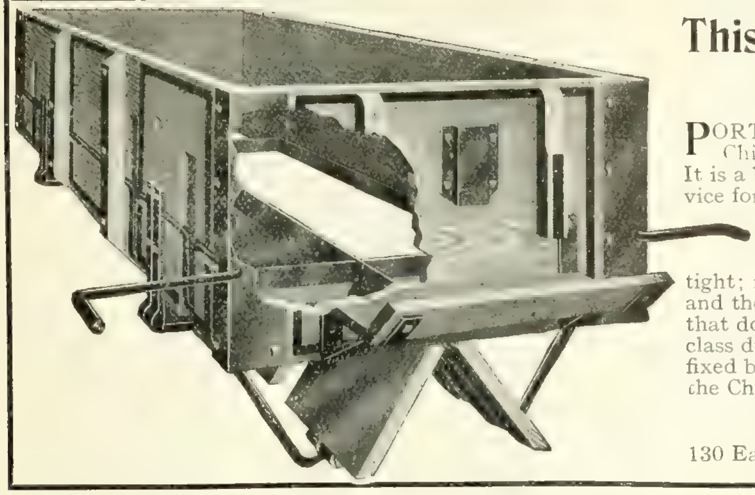
438 Sand blast apparatus.
Sand pump. See 392.
440 Saw mills, portable.
Scale box. See 462.
442 Scarifiers for macadam.
444 Scrapers, drag.
446 Scrapers, road.
Scrapers, wheel. See 528.
448 Screens, rotary.
450 Second hand outfits.
Sewer braces. See 502.
454 Sewer cleaners.
455 Sewer traps.
Sewer pipe. See pipe.
457 Shafting.
458 Sheaves.
460 Shovels, hand.
462 Skips.
464 Slate.
466 Sprinkling carts.
468 Standpipes.
470 Steam shovels.
472 Steel, structural.
474 Steel for reinf. concrete.
476 Stone, broken.
478 Stone dressing mach's.
479 Street sweepers.
480 Stump puller.
482 Switches.

490 Tanks, water.
491 Tapes, measuring.
Tapping mach's. See 375.
492 Tar.
494 Tents.
496 Ties, steel.
498 Tile.
Time keeping devices. See 92.
Traction engines. See 166.
Track laying mach. See 413.
499 Track tools.
500 Tracing cloth.
502 Trench braces.
504 Trench machines.
506 Turntables.

510 Valves, steam.
512 Valves, water.
513 Vault lights.
514 Ventilators.

520 Wagons, dump.
522 Waterproofing.
Well drills. See 138.
526 Wheelbarrows.
528 Wheel scrapers.
530 Windmills.
532 Wire cloth.
Wire rope. See 430.

The above is only a partial list of the headings in our Card Index. No matter what you want, TELL US and we will put you in prompt communication with the leading manufacturers, dealers or contractors.



This is more than a portable dumping box

PORTABLE dumping boxes for wagons are common. The Chicago Quick Dumper is more than a portable dumping box. It is a bottom dump wagon box which by means of a special device for operating the bottom doors distributes the load equally over the front and rear wheels and allows the gear to be coupled up as close as 65 inches. Every teamster knows what this means—it means light draft. The box is sand tight; it fits any wagon gear having a reach. Take off the box and the gear is ready for hauling lumber or poles or anything else that does not need a box. Put on the box and there is a high class dumping wagon at a quarter of the cost of any ordinary fixed box dumping wagon. Our CATALOG No. 22 tells all about the Chicago Quick Dumper. **Over 600 are in use in Chicago.**

BLACK MANUFACTURING CO.

130 East Ohio Street CHICAGO

This is the VERY BEST medium for
PROPOSAL ADVERTISING
because

Engineering-Contracting has upon its subscription list the names of more contractors and contracting engineers than read any other periodical in the world.

ENGINEERING-CONTRACTING
Chicago

The Emerson

Handy Binder

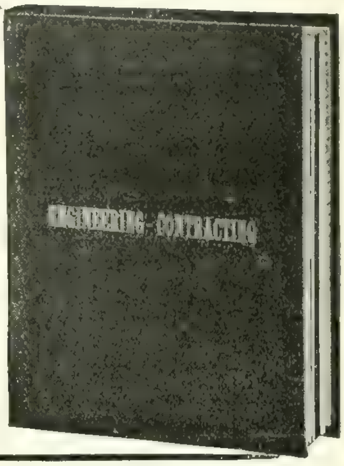
will keep your papers clean and always at hand for quick reference. These binders have for many years been used by libraries and others as the standard binder for holding magazines and other periodicals

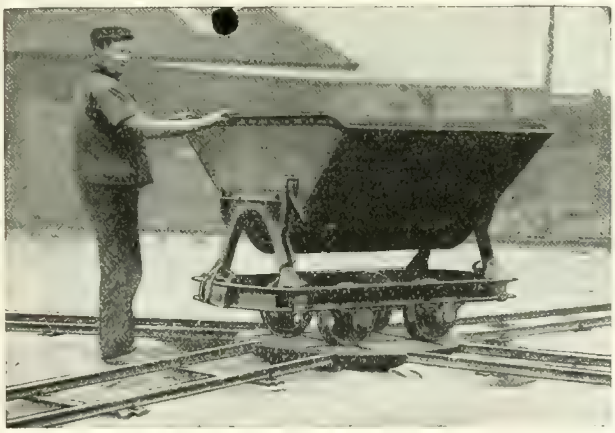
We have them in stock with

ENGINEERING-CONTRACTING

stamped in gold on the front cover. Each binder is made to hold 26 copies of the paper. Price, postpaid, $1.00 each. Every subscriber to Engineering-Contracting should have one of these binders.

ENGINEERING-CONTRACTING
355 Dearborn Street, Chicago





Steel Dump Cars

4, 6 and 12 Yards

Save 50 per cent of cost in grading operations, over old style equipment. Large stock of cars, portable track, rails, switches, turn-tables, etc., always on hand.

We also have track and cars for rent.

WRITE FOR RENTING LIST E

ARTHUR KOPPEL COMPANY

OFFICES AND WAREHOUSES

NEW YORK
139 Morris Bldg.

CHICAGO
311D Monadnock Bldg

BOSTON
53 Oliver St.

PITTSBURGH
1610 Machesney Bldg.

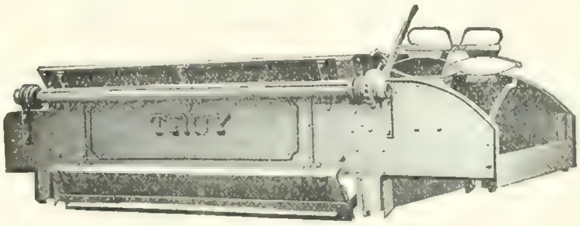
SAN FRANCISCO
1511a Chronicle Bldg.

BALTIMORE
449 Equitable Bldg.

MANY contractors make a practice of renting all their wagons. Consequently they get wagons of all sizes and kinds, but mostly slat bottom wagons of small capacity. Now, by purchasing a number of Troy Dump Boxes, which fit any wagon gear, a contractor can convert any rented wagon into a dump wagon at a cost that is nominal compared with the daily saving effected in dumping alone. Besides, the Troy Dump Box has a large capacity, thus increasing the size of loads carried. There are several kinds of dump boxes in the market, but none so simple and strong as the Troy. Send for BULLETIN E and learn why.

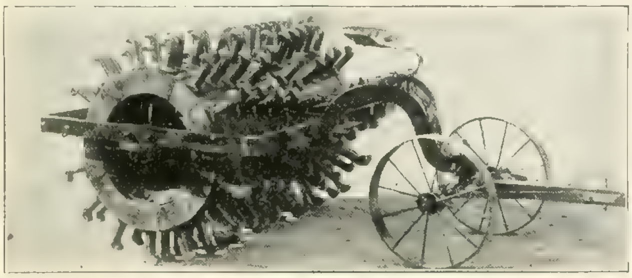
The Troy Wagon Works Co.

295 South Walnut Street TROY, OHIO



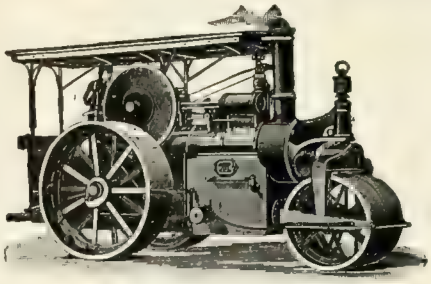
Go Into Road Contracting
AND
Build Petrolithic Roads.

A number of engineers and contractors have recently abandoned all other work and are making a specialty of building Petrolithic roads and streets. Real estate men who are laying out suburban tracts are eager to get a cheap, dustless pavement, and are easily persuaded to use Petrolithic. Once it has been used in any locality, repeat orders are secured, and a profitable business is quickly established. Country roads can be made by the Petrolithic process at less cost than macadam, and they are dustless, even under automobile traffic. By mixing asphaltic oil, Tarvia, or any suitable bituminous product with the natural soil, and by consolidating with a Petrolithic roller, a roadway is produced, that is superior to any other, and at very low cost. It will pay you to investigate. To do so, begin by sending for our new catalog.



Petrolithic Pavement Company
764 Pacific Electric Bldg. Los Angeles, Cal.

KELLY-SPRINGFIELD ROAD ROLLER CO.



Steam Road Rollers, All Types, All Sizes,
Over Eighteen Hundred in Use. Satisfaction Guaranteed.
Send for Catalogue No. 4

SPRINGFIELD, O.

PHILADELPHIA OFFICE, 2132 LAND TITLE BUILDING

"NEW YORK" STEAM ROLLERS

Have Double Engines, Two Speeds,
Differential Gear, Steam Dome

THE "NEW YORK" SCARIFIERS

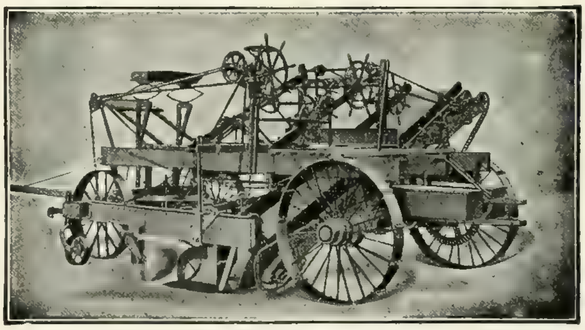
have double-pointed picks

ETNYRE SPRINKLING WAGONS

WRITE FOR CATALOGS

CHARLES LONGENECKER & COMPANY
150 Nassau Street, NEW YORK, U. S. A.

NATIONAL ELEVATING GRADER



Send for Catalogue EC

INDIANA ROAD MACHINE COMPANY
FORT WAYNE, IND.

Remodeled, Handsomely Furnished New Throughout

THE ALBANY

41st Street and Broadway
NEW YORK

ABSOLUTELY FIREPROOF

In the heart of the City

500 Rooms 300 Bath Rooms

European Plan. Cuisine Unexcelled. Gentlemen's Cafe. Ladies' Restaurant and Moorish Rooms. Popular Prices. Plenty of life—but home-like. Single Room and Suites with and without Bath.

$1.00 per Day and up

Send for Booklet

ROBERT P. MURPHY

Some Advantages of

Creosoted Wood Paving Blocks

Smooth as Asphalt.

Durable as Granite Blocks.

Sanitary on Account of antiseptic treatment.

Noiseless to a greater extent than any other pavement.

Appeals to tax payers and contractors alike.

Capacity 3,000,000 yards a year.

Ayer & Lord Tie Company
1123—138 Washington Street
CHICAGO, ILL.

FRANK C. POWERS, Sales Agent

THE TRUTH ABOUT STREET PAVING

generally comes out **after** the pavement has been laid and when it is too late to remedy the mistake.

When Bitulithic is selected and laid no mistake is made. The truth about street paving is then so fully, clearly and convincingly laid bare that there is no longer room for doubt as to the ideal roadway.

Write For Illustrated Booklets.

WARREN BROTHERS COMPANY
BOSTON, MASSACHUSETTS

"Bitulithic" "Puritan" Registered Trade Marks. "Bituminous Macadam" "Bitrock" "Bitustone"

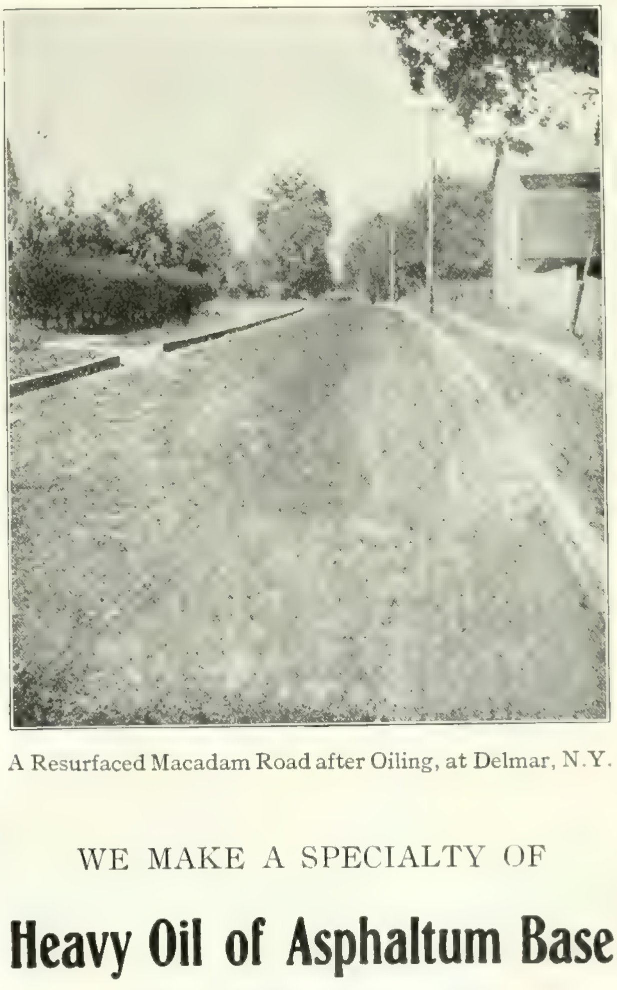
GULF REFINING CO.

REFINER OF

Indian Territory and Texas Petroleum

MANUFACTURER OF

ASPHALT for PAVING and ROOFING



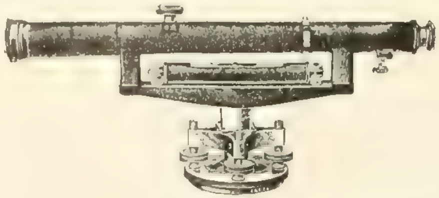
A Resurfaced Macadam Road after Oiling, at Delmar, N.Y.

WE MAKE A SPECIALTY OF

Heavy Oil of Asphaltum Base For Oiling Roads

Prompt shipments from Boston, New York, Philadelphia, New Orleans, Tampa, Fla., and Port Arthur, Texas.

General Offices: Frick Building Annex,
PITTSBURG, PENNSYLVANIA.



ENGINEER'S DUMPY LEVEL

FOR QUICK, ACCURATE WORK
FOR WORK ON ROUGH GROUND

A thoroughly reliable and accurate level of the finest workmanship. Erecting Telescope 18 inches, fine sensitive spirit level graduated on the glass, eyepiece adjustable vertically with patent Micrometer Focusing Arrangement with lock nut. Four Leveling Screws. Telescope bar and tube of spirit level cloth finish. The center is of the K & E Patent Construction. Split Tripod.

OUR COMPLETE CATALOG AND OUR SOLAR EPHEMERIS FOR 1908 (POCKET SIZE) FREE ON REQUEST.

127 Fulton Street,
NEW YORK

KEUFFEL & ESSER CO.,

General Office and Factories
HOBOKEN, N. J.

CHICAGO——ST. LOUIS——SAN FRANCISCO

Drawing Materials Mathematical and Surveying Instruments Measuring Tapes

F. D. CROFOOT N. NIELSEN

Printing by Electric Light

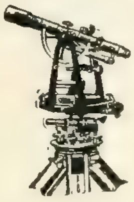
Crofoot, Nielsen & Company

BLUE PRINTERS

Blue Printing, Black Printing Blue Line and Color Printing

Special Service Always—Speed and RESULTS. Big Floor Space and Equipment for Rush Orders.

167-169 E. Washington Street, CHICAGO
Phone 759 Main

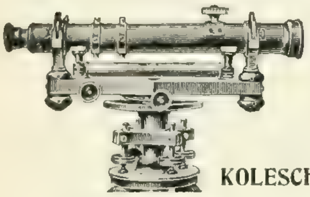


BUFF SURVEYING INSTRUMENTS

You are not going to save money by sitting down and comparing prices of transits. Spend a little time and thought in close investigation of the "Buff."

Send for Catalog No. 3

BUFF & BUFF COMPANY, Boston, Mass.



IS IT LEVEL?

The use of an Architect's Level assures you of correct results and saves time.
Our catalogue describes this and other useful instruments.

KOLESCH & CO., 142 Fulton St., New York

R. SEELIG & SON

172 E. MADISON ST., CHICAGO

MANUFACTURERS OF MOST IMPROVED

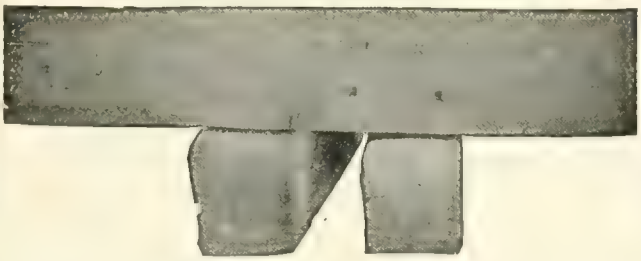
ENGINEERING and SURVEYING INSTRUMENTS

SEND FOR CATALOG No. 6.

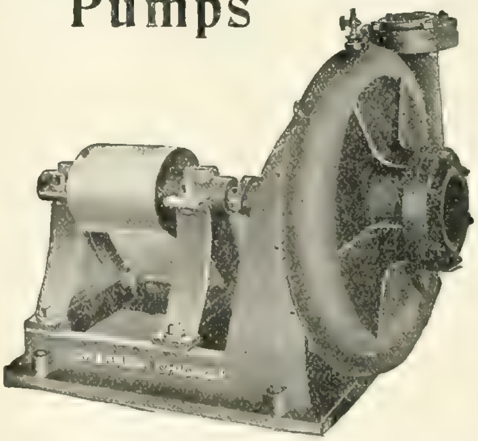
15 Mins. in Hot Paint Gives Life of 15 Yrs.

This photograph shows railroad ties of southern pine that were immersed 15 minutes in hot paint made by this company. After nine years service the ties are as sound as the day they were treated, which means that, at worst, they will have a life of not less than 15 years. The paint contains a germicide that is death not only to the fungus of rot but to teredos and all forms of timber parasites. No engineer who is concerned with the preservation of ties, piles, fences, telegraph and telephone poles, or bridge timbers, can offord not to send for our catalog at once and investigate this paint.

The Teredo-Proof Paint Company
17 Battery Place, New York



Channon Centrifugal Pumps



These pumps are well designed and heavily constructed throughout. The case or shell is of the solid type, very heavy, and the runner of large diameter, adapting the pump for slow speed.

Direct-Connected Outfits of All Kinds

Send for Catalog No. 33
Covering Contractors' Equipment.

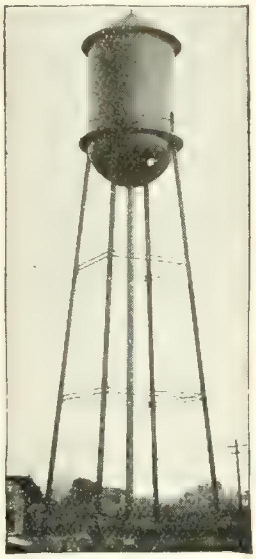
H. Channon Company.
Chicago.

One Way to Save Money

If you are interested in the construction or operation of municipal water works, you can save money for the city by constructing an elevated tank on the system. This will give a uniform static pressure of any amount desired upon the mains, and cause a saving in cost of pumping which will pay for the structure in a very short time, besides affording fire protection which is independent of the operation of pumps for several hours. These illustrations show some of the tanks we have built for this purpose. The cuts are all made to the same scale and give some idea of their comparative sizes, the Louisville tank being the largest in the world. Write for illustrated booklet.

Chicago Bridge and Iron Works
Washington Heights Sta., Chicago.

Capacity 1,200,000 Gals.
Height 220 ft.
Louisville, Ky.
Louisville Water Co.



Capacity 200,000 Gals.
Height 157 ft.
Sycamore, Ill.
City Water Works

Cap'y 40,000 Gals.
Height 98 ft.
Greeley, Neb.
City Water Works

Cap'y 2,000 Gals.
Height 42 ft.
Belton, S. C.
Private Res.

Cap'y 60,000 Gals.
Height 85 ft.
Lock Haven, Ill.
C. P. & St. L. Ry.

McWANE-LYNCHBURG TRADE MARK QUALITY BEFORE QUANTITY

WATER AND GAS WORKS MANAGERS

WRITE FOR CATALOG OF

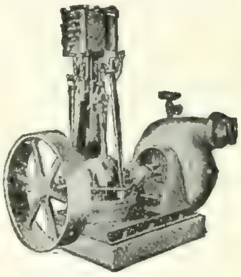
McWANE PIPE WORKS
LYNCHBURG, VA. NEW YORK CITY

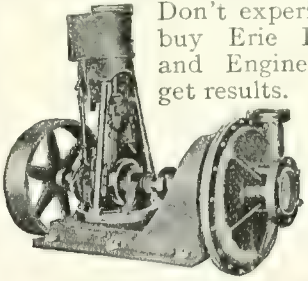
ERIE
Pumps and Engines

have a world-wide reputation for durability and high efficiency. Don't experiment, buy Erie Pumps and Engines and get results.

ASK FOR CATALOG F

ERIE PUMP & ENGINE CO.
ERIE, PA.

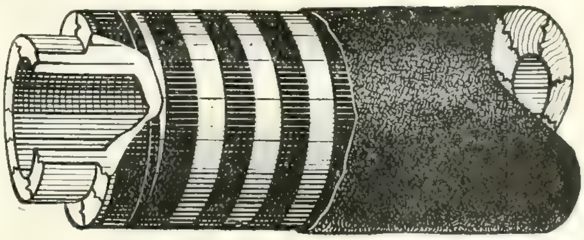


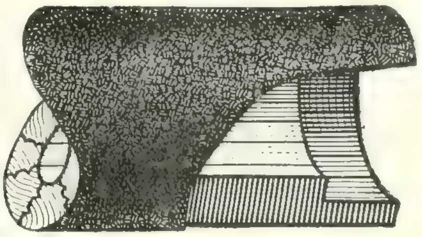


Improved Combination Steel and Wood Pipe

For Municipal Water-Works Systems, Mines, Railroads, Chemical and Iron Works

Strength of Steel
Will Not Rust
Easily Installed





Durable
Cheaper Than Iron Pipe
Keeps Water Conveyed Sweet

WRITE FOR CIRCULARS

THE MICHIGAN PIPE COMPANY, BAY CITY, MICHIGAN

CLASSIFIED DIRECTORY OF ADVERTISERS—(For location of advertisements see Alphabetical Index, page 8).

Air Compressors
American Well Works.
Ingersoll-Rand Co.

Architects' Supplies (See Engineers' Supplies, Instruments etc.)

Artesian Wells, Tools, Pumps
American Well Works.
Cook Well Co.

Asphalt
Barrett Mfg. Co.
Gulf Refining Co.
Standard Asphalt & Rubber Co.
Warren Bros. Co.

Automatic Stokers (See Grates, Traveling Link)

Ballast Unloaders and Spreader
Browning Engineering Co.
Marion Steam Shovel Co.

Bearings—Oilless and Self-Oiling
North Am. Metaline Co.

Blocks—Snatch and Tackle
Chisholm & Moore Mfg. Co.
Patterson Co., W. W.
Union Elevator & Machine Co.

Block Machines (See Concrete Block Machines)

Blue Print Apparatus and Paper
Am. Blue Print Paper Co.
Crofoot, Nielsen & Co.
Fritz & Goeldel Mfg. Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.
Technical Supply Co.

Bolts
Scovil Mfg. & Supply Co.

Books
Audel & Co., Theo.
Clark Pub. Co., Myron C
Engineering News Book Dept.
Nash, A. L.
Technical Supply Co.

Boots for Contractors
Rubberhide Co.

Borings—Test (See Artesian Wells)

Bridges, Roofs, Trusses, Etc.
Chicago Bridge & Iron Wks.
Continental Bridge Co.
Page & Shnable.
Ransome Concrete Machy. Co.

Buckets—Coal, Ore, Dredging
Chandler, Geo. M.
Channon Co., H.
Cyclopean Iron Works.
Hayward Co.
Hough Co., Wm. B.
Kiesler Co.
Northern Engineering Works.
Page & Shnable.
Sackett Screen & Chute Co.
Tide Water Iron Works.
Wiener Co., Ernst.
Williams Co., G. H.

Cableways — Suspension Wire Rope
Balanced Cable Crane Co.
Flory Mfg. Co., S.
Harper Machinery Co.

Car Couplers, Fenders, Fittings, Car Wheels
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Cars
Contin'tl Car & Equip't Co.
Harper Machinery Co.
Hicks Locomotive & Car Wks.
Hough Co., Wm. B.
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Weiner Co., Ernst.

Carts for Concrete, Etc.
Archer Iron Works.
Hough Co., Wm. B.
Ransome Concrete Machy. Co.
Sackett Screen & Chute Co.

Carts and Wagons — Ash and Dump
Black Mfg. Co.
Contractors' Sup. & Equip. Co.
Good Roads Machinery Co.
Hough Co., Wm. B.
Indiana Road Machy. Co.
Ransome Concrete Mach. Co.
Sackett Screen & Chute Co.
Studebaker Bros. Mfg. Co.
Troy Wagon Works Co.

Castings and Forging
American Casting Co.
Green Engineering Co.
Scovil Mfg. & Supply Co.
Tide Water Iron Works.
Vulcan Iron Works.

Cement
Atlas Portland Cement Co.
Chicago Portland Cement Co.
Edison Portland Cement Co.
Lehigh Portland Cement Co.
Marquette Cement Mfg. Co.
Universal Portland Cement Co.

Chains
Hayden-Corbett Chain Co.
Woodhouse Chain Works.

Chain Belts—(See Power Transmission Machinery)

Chimney—Iron and Steel—(See Boilers

Clocks
Prentiss Clock Co.

Coal and Ore Handling and Conveying Machinery, Etc.
Browning Engineering Co.
Brown Hoisting Machy. Co.
Channon Co., H.
Hayward Co.
Hough Co., Wm. B.
Koppel Co., Arthur.
Northern Engineering Works.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Collapsible Centerings
Blaw Steel Centering Co.

Concrete Made Refractory
Stowell, E. R.

Concrete Mixers and Machinery —(See Mixers—Concrete)

Concrete Work—(See Contractors; also Fireproof Construction)

Consulting Forester
Meier, F. R.

Contractors
Caton & Olmstead.
Continental Bridge Co.
Gilbreth, Frank B.
Jackson, Inc., Geo. W.
McGrath, M. P.
Rodgers Co.
Trussed Concrete Steel Co.

Contractors' Supplies and Equipment — (See also Secondhand Supplies)
Archer Iron Works.
Chandler, Geo. M.
Channon Co., H.
Contractors' Sup. & Equip. Co.
Harper Machinery Co.
Hough Co., Wm. B.
Koppel Co., Arthur.
Lucas & Co., R. G.
Sackett Screen & Chute Co.
Scovil Mfg. & Supply Co.
Torbert & Co., A. C.
Union Eltr. & Mach. Co.
U. S. Equipment Co.
Wiener Co., Ernst.

Conveyors and Conveying Machinery—(See Coal and Ore Handling and Conveying Machinery)

Correspondence Courses in Engineering
Concrete Engineering.

Couplings—Friction Clutch
Brown Hoisting Machy. Co.
Browning Engineering Co.
Sackett Screen & Chute Co.

Cranes
Brown Hoisting Machy. Co.
Browning Engineering Co.
Northern Engineering Works.

Crayons and Pencils—(See Engineers' Supplies)

Creosoting
Ayer & Lord Tie Co.

Crossings—Railways (See Frogs)

Crushers and Pulverizers
Chicago Concrete Mchy. Co.
Good Roads Machinery Co.

Culverts
American Rolling Mill Co.
Crawfordsville Corrugated Culvert Co.

Derricks and Derrick Fittings
Browning Engineering Co.
Carson Trench Machine Co.
Contractors' Sup. & Equip. Co.
Flory Mfg. Co., S.
Hough Co., Wm. B.
Northern Engineering Works.
Parker Hoist & Machine Co.
Terry & Tench Co.

Ditching Machinery, Steam Shovels, Etc.
Austin Drainage Excavator Co
Atlantic Equipment Co.
Brown Hoisting Mach. Co.
Browning Machinery Co.
Buckeye Traction Ditcher Co.
Carson Trench Machine Co.
Ellicott Machine Co.
Fairbanks Steam Shovel Co.
Flory Manufacturing Co.
Harper Machinery Co.
Hayward Co.
Hough Co., Wm. B.
Ingersoll-Rand Co.
Marion Steam Shovel Co.
Municipal Eng. & Contrg. Co.
Parsons Co., G. W.
St. Paul Ditcher & Carrier Co.
Souther & Co., John.
Thew Automatic Shovel Co.
Torbert & Co., A. C.
Vulcan Iron Works.
Vulcan Steam Shovel Co.

Drafting Room Furniture (See also Engineers' Supplies)
Berger Mfg. Co.
Fritz & Goeldel Mfg. Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.

Dredging Machinery (See also Ditching Machinery)
Ellicott Machine Co.

Drills—Core, Prospecting
American Well Works.
Cyclone Drill Co.

Drills—Rock and Ore
Cyclone Drill Co.
Ingersoll-Rand Co.
Wood Drill Works.

Dump Wagons (See Carts and Wagons

Dust Collectors
Knickerbocker Co.

Dynamometers
Du Vivier, E. H.

Employment Agencies
Assoc. Union of S. S. & D.
Engineering Agency.
Graham, J. F.
Hapgoods.
Int. Bro. of S. S. & D'men.

Engineers—Civil, Consulting and Mechanical—(See Engineers' Directory)

Engineers' Supplies, Instruments, Etc.
Am. Blue Print Paper Co.
Buff & Buff Co.
Crofoot, Nielson & Co.
Keuffel & Esser Co.
Kolesch & Co.
Prince, L. M.
Ruehle & Co., E. G.
Seelig & Son, R.
Young & Sons.

Engines—Gas, Gasoline and Oil
American Well Works.

Engines—Hoisting
Brown Hoisting Mach. Co.
Channon Co., H.
Flory Mfg. Co., S.
Harper Machinery Co.
Hough Co., Wm. B.
Northern Engineering Works.
Stroudsburg Engine Works.

Engines—Stationary and Pumping
American Well Works.
Channon Co., H.
Cook Well Co.
Erie Pump & Engine Co.
Harper Machinery Co.
Hough Co., Wm. B.
Stroudsburg Engine Works.

Engines—Traction
Harper Machinery Co.

Expanded Metal—(See Fireproof Construction)

Excavating Machinery — (See Ditching Machinery)

Fence and Railing
Anchor Post Iron Works.

Fence Posts—Iron
Anchor Post Iron Works.

Filing Cases (See Drafting Room Furniture)

Filters—Water
New York Continental Jewell Filtration Co.
Norwood Engineering Co.

Fireproof Construction
Berger Mfg. Co.
Calumet Steel Co.
Concrete Column & Const. Co.
Hough Co., Wm. B.
Ransome Concrete Mach. Co.
Rodgers Co.
Trussed Concrete Steel Co.

Forms for Concrete Work.
Dietrichs Co., Charles.
Sullivan, J. H.

Frogs, Crossings and Switches —Railway
Cincinnati Frog & Switch Co.
Indianapolis Switch & Frog Co.
Koppel Co., Arthur.
Weiner Co., Ernst.

Furniture and Office Fittings— (See also Drafting Room Furniture)
Berger Mfg. Co.
Keuffel & Esser Co.

Gauges—Recording
Du Vivier, E. H.

Graders and Scrapers — Earth (See Road Machinery)

Grates—Traveling Link
Green Engineering Co.

Grout Mixer and Injector
Tide Water Iron Works.

Hoists
Hayward Co.
Hough Co., Wm. B.
Ingersoll-Rand Co.
Ransome Concrete Machy. Co.

Hoists—Electric
Grable-Dunn Co.
Northern Engineering Works.

Hoists—High Speed Chain
Chisholm & Moore Mfg. Co.

Hose and Fittings
Ingersoll-Rand Co.

Hydrants
Norwood Engineering Co.

Industrial Railways
Cincinnati Frog & Switch Co.
Koppel Co., Arthur.
Sackett Screen & Chute Co.
Wiener Co., Ernst.

Inspection of Iron and Steel
Am. Bureau of Insp'n & Tests.
Conard, W. R.

Insulating Materials
Barrett Mfg. Co.
Standard Asphalt & Rubber Co.

Iron and Steel Work
Chicago Bridge & Iron Works.
Continental Bridge Co.
Jackson, Inc., George W.

Iron—Sheet and Ingot
American Rolling Mill Co.

Laborers Furnished—(See Employment Agencies)

Author Vol. 29, Jan-June/08 104838
Title Engineering-Contracting

UNIVERSITY OF TORONTO
LIBRARY

Do not
remove
the card
from this
Pocket.

Acme Library Card Pocket
Under Pat. "Ref. Index File."
Made by LIBRARY BUREAU